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Vol. IV

TRANSCRIPT OF RECORD

NARRATIVE STATEMENT OF PATENT EVIDENCE

Supreme Court of the United States

OCTOBER TERM, 1930

No. 378

STANDARD OIL COMPANY (INDIANA), STANDARD OIL COMPANY (NEW JERSEY), STANDARD DEVELOPMENT COMPANY, ET AL., APPELLANTS,

vs.

THE UNITED STATES OF AMERICA

APPEAL FROM THE DISTRICT COURT OF THE UNITED STATES FOR THE NORTHERN DISTRICT OF ILLINOIS

FILED AUGUST 22, 1930

(35,300)

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VOL. IV

INDEX

	Original	Print
Narrative statement of evidence relating to patents	1	2111
Petitioner's interrogatories	1	2111
Answers to interrogatories, Standard Oil Co. (New Jersey)	7	2115
Answers to interrogatories, Standard Oil Co. (Indiana)	26	2135
Answers to interrogatories, The Texas Co.	59	2175
Answers to interrogatories, Gasoline Products Co.	86	2204
Answers to interrogatories, Standard Oil Co. (New York)	92	2212
Stipulation re Standard Oil Co. (New York)	94	2214
Testimony of Ralph H. McKee	95	2215

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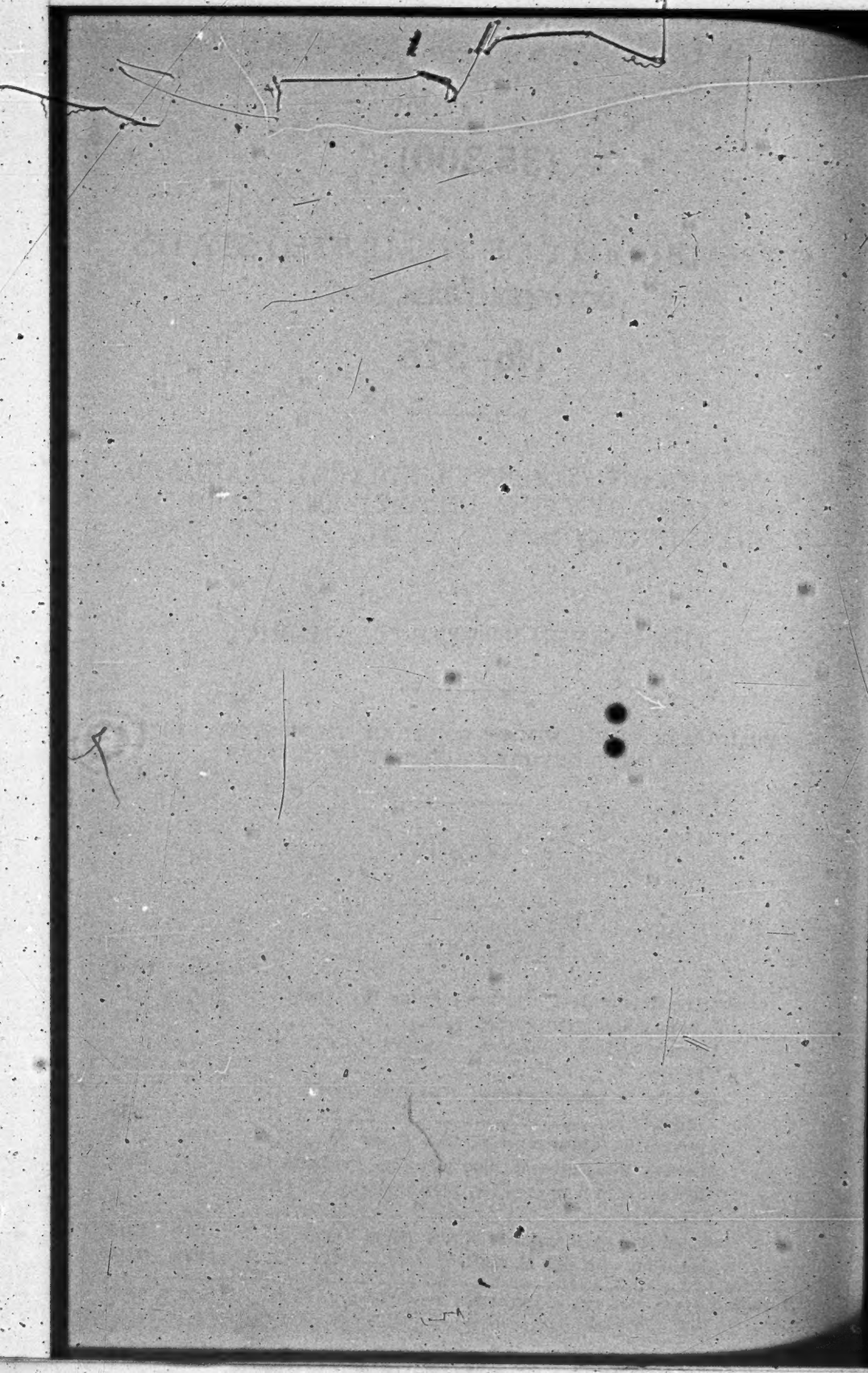

[fol. 1] IN UNITED STATES DISTRICT COURT

Narrative Statement of Evidence Relating to Patents

ABSTRACT OF PETITIONER'S INTERROGATORIES

Petitioner's Interrogatories I to LXVIII inclusive are in the following form:

"Does the defendant use, or has it used in the operation of its cracking process or processes, or in connection therewith or embodied in plans and/or specifications approved by it or furnished by it to its licensee or licensees and, and, if so, which of the following apparatus and for what periods of time and to what extent."

Following this introductory clause in each interrogatory are set forth in extenso the claims of one of the process patents of the primary defendants so that each interrogatory has as many subdivisions as there were claims in the particular patent alluded to. The relation between the interrogatories and the patents is accurately shown in Chart No. 1 attached to the answers of the Standard Oil Company of Indiana, and therefore, since the claims appear in the patents in question, the interrogatories I to LXVIII are omitted.

Interrogatory LXIX was as follows:

LXIX. Has the defendant formed or does it form, in the development and/or operation of the cracking process or processes covered in its patent or patents involved in its license agreements, substantial quantities of a gasolene-like material substantially different in any way from that normally produced from natural crudes by fractional distillation?

[fol. 2] Interrogatory LXX in its introductory clause reads as follows:

LXX. If yes in interrogatory LXIX, has the defendant formed or does it form any of the following products, and,

if so, which, of the following product or products and in what relative proportion to other gasolenelike products of its cracking process or processes?

[fol. 3] Following this introductory clause are 68 claims copied verbatim from various product patents of the primary defendants. Subdivisions 1 to 15 are the claims of the Ellis Patent 1,318,060. Subdivisions 16 to 45 are claims 1 to 30 of the Hall patent 1,230,099. Subdivisions 46 to 64 are claims 1 to 9 inclusive of the Hall patent 1,239,900. Subdivisions 65 and 66 are Claims 13 and 14 of patent 1,396,999 and subdivisions 67 and 68 are claims from Clark patent 1,413,260. Inasmuch as these claims appear elsewhere in the record, they are omitted.

[fol. 4] Interrogatories LXXI to LXXV follow:

LXXI. Does the defendant treat or has it treated cracked gasolenelike material resulting from the operation of its patented process or processes (and containing unsaturated bodies) with diluted sulphuric acid, and, if so, approximately what portion of its gasolene like material is so treated?

LXXII. Does the defendant treat or has it treated gasolene-like material resulting from the operation of its patented process or processes (and containing unsaturated bodies) with concentrated or undiluted acid of approximately 66° Be., and, if so, approximately what portion of its gasolenelike material is so treated.

LXXIII. What is the concentration and gravity of the acid or acids normally used in the treatment of gasolene-like material resulting from the operation of the patented process or processes of defendant?

LXXIV. Does the defendant, in the operation of its patented process or processes, to produce gasolene-like material adapted for use as a motor fuel; subject a heavier hydrocarbon to a cracking temperature whereby such hydrocarbon is cracked and gasolene-like material containing a substantial amount of unsaturated bodies produced, separate gasolene-like material containing a substantial amount of unsaturated bodies from the resulting product and subject the separated material to the action of sulphuric acid

of such strength that in its reaction with the unsaturated bodies present in the gasolene-like material a portion of such bodies are removed and no substantial and permanent discoloration of the gasolene-like material is produced?

LXXV. Has the defendant, in purifying or treating gasolene-like material resulting from the operation of its patented process or processes, treated such gasolene-like material with acids of different strengths than those mentioned above or with other equivalent purifying agents, and, if so, to what extent has it used such alternative materials?

[fol. 5] Interrogatories LXXVI-LXXVIII inquire as to the production by the defendants of a product of the three claims of the Burton Patent No. 1,167,884:

LXXVI. Does the defendants, in the operation of its patented process or processes, form a petroleum oil characterized by the following approximate relation between its gravity and its viscosity:

$$.51x^2—106xy—961x—29y^2—244y—53296=0$$

were "x" is the viscosity at 100° F. according to the Saybolt viscosimeter and "y" the Baume gravity of the oil?

LXXVII. Does the defendant, in the operation of its patented process or processes, form a petroleum distillate produced by the following process: distilling an oil having a boiling point of upward of 500° F. at a temperature from about 650° F. to 850° F. and under a pressure of upward of three atmospheres until about 65% of the oil has distilled over, drawing off the residue from the pressure still, distilling the latter under approximately atmospheric pressure, and condensing and collecting the distillate?

LXXVIII. Does the defendant, in the operation of its patented process or processes, form a petroleum oil having a Baume gravity of approximately 15° and a viscosity of approximately 130° as measured by the Saybolt viscosimeter at 100° F. and comprising a mixture of fractions mainly of the paraffin series and having a Baume gravity varying approximately from 20° to 10° and a corresponding viscosity ranging approximately from 50 to 200?

[fol. 6] Interrogatories LXXIX-LXXXIII are as follows:

LXXIX. Has the defendant developed and placed in commercial operation any of the processes or methods disclosed in Palmer Patents Nos. 1,187,380, 1,313,009 and/or 1,360,973; and, if so, what, if any, changes and/or modifications has it made in such development over the disclosures of said patents?

LXXX. In its commercial cracking operations, does the defendant use or has it used any part of the apparatus and/or any part of the processes or methods described and shown in the following patents, and, if so, what portion of the apparatus and what process steps has it used and to what extent and for what periods of time?

Adams Patent No. 1,320,354.
Adams Patent No. 1,320,726.
Adams Patent No. 1,320,727.
Adams Patent No. 1,327,263.
Adams Patent No. 1,428,311.
Adams Patent No. 1,428,312.
Adams Patent No. 1,433,519.
Adams Patent No. 1,445,281.
Adams Patent No. 1,455,376.
Adams Patent No. 1,461,017.
Adams Patent No. 1,462,677.
Adams Patent No. 1,477,860.
Adams Patent No. 1,506,877.
Hall Patent No. 1,175,909.
Hall Patent No. 1,175,910.
Hall Patent No. 1,194,289.
Hall Patent No. 1,242,795.
Hall Patent No. 1,242,796.
Hall Patent No. 1,285,136.
Hall Patent No. 1,261,930.

LXXXI. What, if any, of the elements of the apparatus or step of the processes or methods disclosed in the above patents have been discarded in the commercial development and operation of their cracking processes and apparatus?

LXXXII. Has the defendant, or did it at any time have, agreements with any of the other defendants designated in the Bill of Complaint as "primary defendants" relating to

the royalties to be charged to licensees, the division of royalties received from licenses, the filing and prosecution of suits for infringement or the defense of infringement suits or relating to other matters in connection with cracking patents other than the agreements listed in the Bill of Complaint?

LXXXIII. If the defendant has any such agreement or agreements, will it furnish plaintiff a copy of each and every of said agreement or agreements?

NOTE.—Of the foregoing interrogatories, each of the above named defendants is required to answer interrogatories I to LXXVIII inclusive, LXXXII and LXXXIII, the Standard Oil Company of Indiana is, in addition, required to answer LXXIX and the Texas Company to answer LXXX and LXXXI.

[fol. 7] STANDARD OIL CO. (NEW JERSEY) ANSWER TO INTERROGATORIES

STATE OF ILLINOIS,
County of Cook, ss:

Frank A. Howard, being duly sworn, deposes and says:

I am President of the Standard Development Co., one of the Defendants named in the above entitled action. That Company is a subsidiary of the Standard Oil Co. (a New Jersey corporation, to which I shall refer as the New Jersey Company), and hold title to and administers all patents of the New Jersey Company.

I am Manager of the Development Department of the New Jersey Company, which department is responsible for the design of the New Jersey Company's cracking equipment and for the determination of the operating methods, or fixing of operating standards, in connection therewith. I am also a member of the Manufacturing Committee of the New Jersey Company, and in such capacity share with the other members of the Committee the responsibility for the operation of all of the cracking processes and equipment of the company.

I have been instructed by the New Jersey Company to obtain all the information available bearing upon the interrogatories filed by the Petitioner in the above-entitled action, and to work with and under the instructions of counsel for the Company in the preparation of the answers to those interrogatories.

A copy of the interrogatories was furnished to me by counsel for the Company within a few days after the date which the interrogatories bore, and since that time I have directly and through my subordinates and in consultation with patent counsel for the Company, diligently studied the interrogatories and sought to obtain such information as would enable the defendant to answer them fully and completely.

I find that the interrogatories relate, in large part, to claims which appear in 72 different patents, there being upwards of 700 of such claims, and as to nearly all of these claims the Defendant is required to tell whether it has used in the operation of its cracking process or processes, or in connection therewith, or embodied in plans or specifications approved by it or furnished by it to its licensee or licensees, [fol. 8] the apparatus or process described in the claims, and for what period of time and to what extent.

The patent counsel for the Company are, and I am, familiar with the patents belonging to the New Jersey Company and the Standard Development Company which were issued upon applications originating within either of these companies but neither I nor the Patent counsel for the company have such detailed familiarity with the other patents, and their individual claims, referred to in the interrogatories.

After preliminary careful consideration of the interrogatories and consultation with counsel, I determined that the first step toward answering the interrogatories would be to clas-ify them, if possible. The following appeared to be a convenient classification:

Class 1. Interrogatories which appear clearly to define the general or common practice of the New Jersey Company in its cracking operations.

Class 2. Interrogatories which appear clearly not to define the general or common practice of the New Jersey Company.

Class 3. Interrogatories which cannot be definitely answered without further study and investigation.

It appeared to be feasible at once to designate the type of cracking operations conducted by the Defendant in which the matters defined in the various interrogatories of the first class were utilized. The New Jersey Company employs commonly and as a matter of regular commercial practice two types of cracking process, i. e., the type generally referred to as the "Burton Process" and the type generally referred to as the "Tube-and-Tank Process". The Defendant has heretofore supplied to the Petitioner in this case, by way of answer to a certain questionnaire submitted by the Petitioner, a full schedule showing the extent of its application and use of each of these two processes. Furthermore, it is true that all licenses of the New Jersey Company (being, more accurately speaking, licensees of the Standard Development Co., which issues licenses under the patents which it owns and administers for the New Jersey Company) have been supplied with full details of all commercial operations of the Tube-and-Tank Process of the New Jersey Company.

With reference to some of the interrogatories falling within the first class, I am familiar with the fact that some particular inventions identified in those interrogatories were for substantial periods of time in regular commercial [fol. 9] use on a substantial scale, but as to the exact period of time or as to the exact scale of use I have not as yet been able to obtain information, it, in many cases, not being contained in any definite or easily available records but being dependent upon the recollections of various employees, with whom it has not yet been possible to get in touch.

There is appended hereto and made a part hereof a schedule containing the information in as complete a form as I have as yet been able to obtain, the same covering the classes of interrogatories which I have designated as Classes 1 and 2, the interrogatories, in so far as they consist of claims of patents, being construed in the light of the inventions described in the patents of which they form a part.

The interrogatories which are answered "Yes" in the Schedule are those of Class 1, and, taken in connection with

the answers to the above mentioned questionnaire, the answers are complete as to those interrogatories.

The interrogatories which are answered "No" in the Schedule are those of Class 2, and the answers to those interrogatories are complete as to the New Jersey Company's general or common practice, and I believe them to be complete as to the commercial practices of the New Jersey Company even though such commercial practices did not come into general or common use. But that latter matter is under further investigation.

The interrogatories which are answered "To some extent", or "sometimes", or in words of similar import, are not fully answered in that the duration and extent of such use are not stated. That information has not yet been obtained, but further investigation along that line will be carried out if the Petitioner so desires.

In the Schedule there are some blanks. These occur in the cases of:

(A) Interrogatories concerning which neither I nor my technical advisers nor patent counsel for the Company have, in the limited time available to them up to the present, been able to reach a conclusion on the precise meaning of the interrogatory or its application to the Company's practices;

(B) Interrogatories couched in terms which will require laboratory investigations before answers can be made; or

(C) Interrogatories relating to details of construction and operation which are known to me and to the technical advisers and operators whom I have consulted to have been changed but which changes must be ascertained by [fol. 10] more prolonged investigation in the company's refineries before it will be possible to give definite answers.

I have in good faith and on the advice and with the assistance of counsel diligently sought to prepare, in the time available since the receipt of the interrogatories, the information necessary to answer the same fully and completely, but this has not been possible.

If the Petitioner desires complete answers, I estimate that at least sixty days' additional time will be required to answer all of the interrogatories to the full extent to

which the information necessary therefor can be obtained, this estimate being made upon the basis of conducting the necessary laboratory work, review of records, consultation with operating officials and employees, and with counsel.

However, it may be that the Petitioner, after considering the answers now given, will not desire further information as to various of the interrogatories and that, in this way, the inquiry may be shortened.

It is, accordingly, suggested that this affidavit and the Schedule attached hereto be taken as the answer of the Standard Oil Company (New Jersey), subject, however, to the right of the Petitioner to demand further and more complete answers in particulars to be specified by it.

Frank A. Howard.

Subscribed and sworn to before me this 7th day of May, 1925. Howard A. Moore, Notary Public. My commission expires Jan. 27, 1927.

[fol. 11]

Exhibit A

	Interrogatory number	Burton Process as practiced by Standard Oil Co. (N. J.)	Tube and tank process
I.	1-7	No	No.
II.	1 and 2	Yes	No.
III.	1 and 2	No.	No.
IV.	1 and 2	To some extent	No.
V.	1 and 2	No.	No.
VI.	1-3	Yes	No.
VII.	1 and 2	Yes	No.
VIII.	1-5	Formerly, to some extent	No.
IX.	1-4	Formerly, to some extent	No.
X.	1-19	No	No.
XI.	1-6	Yes	
XII.	1	Formerly, to some extent	No.
XIII.	1-4	Yes	No.
XIV.	1-3	Yes	No.
XV.	1-3	No	No.
XVI.	1-3	No	No.
XVII.	1-7		
XVIII.	1 and 2	To some extent	No.
	3	No	No.
	4	No	No.
	5	No	
	6	No	
XIX.	1-4	Yes	No.
XX.	1-3		
XXI.	1-3	No	No.
XXII.	1-4	No	No.
XXIII.	1-6	No	No.
XXIV.	1-10	No	No.
XXV.	1-3	No	No.
XXVI.	1-6	No	No.

"Exhibit B"—Continued

	Interrogatory number	Burton Process as practiced by Standard Oil Co. (N. J.)	Tube and tank process
XXVII.	1-9	No	No.
XXVIII.	1-23	No	No.
XXIX.	1-11	No	No.
XXX.	1-12	No	No.
XXXI.	1	No	Yes.
	2	No	Yes.
	3	No	Formerly, not now.
	4	No	Yes.
	5	No	Yes.
	6	No	Yes.
	7	No	Formerly, not now.
	8	No	Yes.
	9	No	Yes.
	10	No	Yes.
XXXII.	1-8	Formerly, not now	No.
XXXIII.	1-4	No	No.
XXXIV.	1-6	No	No.
XXXV.	1-7	No	
XXXVI.	1-7	No	No.
	8		No.
	9		No.
	10	No	No.
	11		No.
	12	No	No.
	13		
	14		
	15		No.
	16		No.
[fol. 12]	17		
	18	No	
	19	No	
	20-22	No	No.
	23 and 24		
	25-28	No	No.
XXXVII.	1-5	No	No.
	6	No	
	7-11	No	No.
XXXVIII.	1	No	No.
	2 and 3		
	4		
	5	No	No.
	6 and 7	No	
	8-28	No	No.
XXXIX.	1 and 2		No.
	3	No	No.
	4-7		
	8	Yes	No.
	9-12		No.
	13	No	No.
	14-15		No.
	16	No	No.
	17	No	
	18-23	No	No.
	24-29		No.
	30 and 31	No	No.
XL.	1-9	No	No.
XLI.	1-7	No	No.
XLII.	1-9	No	No.
XLIII.	1-11	No	No.

"Exhibit A"—Continued

	Interrogatory number	Burton Process as practiced by Standard Oil Co. (N. J.)	Tube and tank process
XLIV.	1 and 2	No	No.
	3		No.
	4 and 5	No	No.
	6-9		No.
	10	Yes.	
	11		No.
	12 and 13	No	No.
	14	No	
	15	No	No.
	16-19	No	
	20-22	No	No.
	23	No	
	24	No	No.
	25	No	
	26-28	No	No.
XLV.	1-9	No	No.
XLVI.	1-9	No	No.
XLVII.	1-14	No	No.
XLVIII.	1-22	No	No.
XLIX.	1-8	No	No.
L.	1-32	No	No.
LI.	1-23	No	No.
LII.	1-5	No	No.
LIII.	1-8	No	No.
	9	No	
	10	No	No.
	11-17	No	No.
	18	No	
LIV.	1-17	No	No.
[fol. 13]	2	No	No.
LV.	1-11	No	
LVI.	1	No	No.
	3		
	4-7	No	No.
	8 and 9		
LVII.	1 and 2	No	
	3	No	No.
	4	No	
	5	No	No.
	6	No	No.
	7	No	No.
	8	No	No.
	9	No	No.
	10	No	No.
	11	No	No.
	12	No	No.
	13	No	No.
	14	No	No.
	15	No	No.
	16	No	
	17	No	No.
	18	No	No.
	19	No	No.
	20	No	No.
	21	No	No.
	22	No	No.
	23	No	No.
	24	No	No.
LVIII.	1-7	No	No.

"EXHIBIT A"—Continued

	Interrogatory number	Burton Process as practiced by Standard Oil Co. (N. J.)	Tube and tank process
LVIX.	1 and 2	No	No.
LX.	1 and 2	No	No.
	3-6	No	No.
LXI.	1-3	No	No.
LXII.	1-13	No	No.
LXIII.	1-4	No	No.
	5 and 6	No	No.
LXIV.	1	No	No.
LXV.	1-35	No	
LXVI.	1	No	No.
LXVII.	1-25		No.
LXVIII.	1-9	Yes	
LXIX.	1	Yes	
LXX.	1-15	Yes	
	16-45		
	46-64		
	65 and 66	No	
	67 and 68	Yes	
LXXI.		Yes, to some extent	
LXXII.		Yes, to some extent	
LXXIII.		60° to 66° B acid	
LXXIV.		Yes	
LXXV.		Yes, to some extent	
LXXVI.			
LXXVII.			
LXXVIII.			
LXXXII.		No, except that it has been arranged without formal contract that the S. O. Co. of Ind. and the Texas Co. will agree to accept $50.000 per unit per day from the Jersey Co. on account of Beacon Oil Co.'s operations in lieu of 5c. per barrel.	
LXXXIII.		Have no such agreements except as above.	

[fol. 14] Further Answers of the Defendants Standard Oil Company (New Jersey) and Standard Development Company to Petitioner's Interrogatories Filed April 3, 1925

The following is a supplemental and further reply of the Defendants, Standard Oil Company (New Jersey) and Standard Development Company to Petitioner's Interrogatories filed April 3, 1925, and embodies answers to Interrogatories not answered in Defendants' answer filed on or about May 7, 1925:

Interrogatory XI

Clark Patent #1,129,034, of February 16, 1915

Apparatus Claims 1-6

In the operation of Defendant's Tube-and-Tank Process, the oil passes through the heating coil; thence through one

or more of the soaking drums, coming in at the base of the drum and out at the top of the drum; thence past a pressure release valve, in which the pressure is reduced to 25 to 60 lbs.; and thence into a vapor separator.

The vapor separator referred to is a vertical cylindrical vessel 10′ in diameter and 30′ in height, insulated against loss of heat, and operating under a pressure of 35 to 60 lbs. gauge. The lower section of the vapor separator is empty, and it is into this section that the oil products are discharged from the soaking drum. In the top of the vapor separator there are mounted coils, through which cold liquid, water or oil is pumped for the absorption of heat. Below the coils there are arranged a plurality of bubble pans of ordinary rectifying column construction. Below the bubble pans there is mounted a collecting pan for the reflux condensate. Three products are withdrawn from the vapor separator, as follows:

1. Tar from the base of the separator;

2. Reflux condensate from the pan; and

3. Naphtha vapors from the top of the column.

The naphtha vapors pass to a condenser, where they are condensed under a pressure approximately the same as that which exists in the column.

If the "stills" referred to in these claims are, for the purposes of the Clark invention, the equivalent of the vapor separators used by the Defendant in the Tube-and-Tank Process, then the Defendant uses this construction.

[fol. 15] Interrogatory XVII

Lewis & Cooke Patent #1,392,584, of October 4, 1921

The operation of Defendant's Tube-and-Tank Process has been described in answer to Interrogatory XI. The dimensions of the heating coil and soaking drum and the range of temperatures and pressures employed are also specifically described in answers to other Interrogatories.

The cycle stock referred to in subdivision 2 of this Interrogatory is reflux condensate which collects in the pan of the vapor separator. The distillate referred to in the answer to subdivisions 4 to 7 is made up of the condensed vapors leaving the top of the vapor separator, as hereto-

fore described in connection with the construction and operation of this portion of the construction.

Subdivisions 1 & 3 (Claims 1 & 3 of the Patent)

If, for the purposes of the Lewis & Cooke invention, the operation of the heating coil, soaking drums and vapor separator used in Defendant's Tube-and-Tank Process, is the equivalent of the operation of the pressure still of Lewis & Cooke patent, then the Defendant uses this Process.

Subdivision 2

Same as 1, in those cases in which Defendant returns cycle stock from the vapor separator to the heating coil, which practice is common but not universal.

Subdivisions 4 & 7

Same as 1, except that Defendant does not commonly condense all non-gasolene-like hydrocarbons, generally producing a distillate of 460 to 500° F. end point and only occasionally one as low as 425 to 450° F.

Subdivision 5

5 is a combination of 2 and 4, the answers to which would combine the answers to 2 and 4.

Subdivision 6

No.

[fol. 16] Subdivisions 1-7

In so far as the subdivisions of this Interrogatory relate to the Burton Process as practiced by Defendant, the Defendant formerly operated to a substantial extent in accordance with all of these claims and had many variations of practice in this respect, the details of which have not yet been determined and which probably cannot be determined in a relatively short time nor with absolute completeness. It is believed that these operations were on more than 200 stills and extended over a period of more than two years.

Interrogatory XVIII

Burton & Clark Patent #1,448,254, of March 13, 1923

Subdivisions 5 & 6 (Claims 5 & 6 of the Patent)

If for the purposes of the Burton & Clark invention, the Defendant's soaking drums and heating coils and vapor separator are the equivalent of the still and heating tubes of the patent, then the Defendant uses the process in its practice of the Tube-and-Tank Process, in which it returns cycle stock from the vapor separator to the heating coil. This last practice is common but not universal.

Interrogatory XX

Palmer Patent #1,187,380, of June 13, 1916

Subdivisions 1-3 (Claims 1-3 of the Patent)

If for the purposes of the Palmer invention, the continuous cracking with continuous evolution and release of volatile products of the reaction together with the non-volatile products thereof, which takes place in the soaking drums of the Defendant's Tube-and-Tank Process, is the equivalent of the digestion step described as carried out in the Palmer digester 10, then the Defendant uses the process of all of these Palmer claims in all of its Tube-and-Tank Cracking operations.

The Defendant adopts as its answer to the subdivisions of this Interrogatory, the supplemental answers of the Defendant, Standard Oil Company (Indiana) in so far as these answers relate to the operation of the Shell Radiator and Tube Radiator Types of installations in the practice of the Burton Process by Defendant.

[fol. 17] Interrogatory XXXV.

Clark Patent #1,478,102, of December 18, 1923

Subdivisions 1-7 (Claims 1-7 of the Patent)

Formerly to a limited extent, not now.

The practice in which this procedure was employed, while not now in use, is not regarded by the Defendant as necessarily permanently abandoned. Defendant has, and

can have, no knowledge as to whether it will or will not have occasion to again employ this practice in the future.

Interrogatory XXXVI

Adams Patent #1,320,354 of October 28, 1919

Subdivisions 13, 14 & 23

If, for the purposes of the Adams invention, the heating coil of the Defendant's Tube-and-Tank Process which coil is approximately 4″ in diameter by 2,500′ in length and discharges into vertical insulated and unheated soaking drums of 6′ diameter by 30 and 40′ height, is the equivalent of the heating section A and dome E of the Adams patent, and if the external firing of this coil is the equivalent of the internal heating by heater 107 of Adams, then the Defendant uses an apparatus described by these claims.

Subdivisions 17 & 24

If in Defendant's Tube-and-Tank Process, the vapor separator into which the products of cracking discharge at a lower pressure, is the equivalent of the trap 113 of the Adams patent, and if the parts of the apparatus used in Defendant's Tube-and-Tank Process which are referred to in the answer to Subdivisions 13, 14 and 23, are the equivalent for the purposes of the Adams invention of the parts of the Adams apparatus referred to, then Defendant uses the apparatus described by Claims 17 and 24 of the Adams patent.

Subdivision 18

No.

Subdivision 19

No.

[fol. 18] Subdivisions 8, 9, 11, 13, 14, 15, 16, 17, 23 & 24

The Defendant adopts as its answer to the hitherto unanswered subdivisions of this Interrogatory, the Supplemental answers referred to, both general and specific, of the Defendant, Standard Oil Company (Indiana), in so far

as they relate to the use of Shell Radiator and Tube Radiator Types of Pressure Stills, in the practice of the Burton Process by Defendant.

Interrogatory XXXVII

Adams Patent #1,320,726, of November 4, 1919

Subdivisions 6 & 7

If the operation of the heating coil of Defendant's Tube-and-Trunk Process is the equivalent, for the purposes of the Adams invention, of the operation of the cracking chamber 9 of Adams, and if the soaking drums discharging through pressure release valves into a vapor separator are the equivalent of the Adams converter C and condenser D, then Defendant uses the process described.

The answer given in Defendant's original answer filed May 7, 1925 to Subdivision 7 of Interrogatory XXXVII was in error. The correct answer is given just above.

Interrogatory XXXVIII

Adams Patent #1,320,727, of November 4, 1919

Subdivision 3

The Defendant has not used the apparatus either in the practice of its Tube-and-Tank Process or in the practice of the Burton Process.

Subdivisions 2, 4, 6 & 7

If the heating coil and soaking drum of Defendant's Tube-and-Tank apparatus are the equivalent of the chamber 18 and dome D of the patent, for the purposes of the invention of the Adams patent, then the Defendant uses the apparatus described.

[fol. 19] Subdivisions 2 & 4

The Defendant adopts answers of Defendant, Standard Oil Company (Indiana) in so far as they relate to Shell Still and Tube Still operations, in the practice of the Burton Process by Defendant.

Interrogatory XXXIX

Adams Patent #1,327,263, of January 6, 1920

The Defendant adopts as its answers to Subdivisions 1, 2, 4-7, 9, 10, 12, 15, 24-29, the Supplemental answers of Defendant, Standard Oil Company (Indiana) so far as they relate to the use of the Tube or Shell Type Equipment, in the practice of the Burton Process by Defendant.

Corrected Answer to Subdivision 8

The pressure in the Defendant's heating coil is from 25 to 50 pounds greater than in the soaking drum, where the pressure is 250 to 350 pounds per square inch. This pressure difference is due to friction and liquid head only. If, for the purposes of this invention, this relation of pressures is the equivalent of that obtaining in heater 12 and dome X of the Adams patent and if the Defendant's operation of withdrawing liquid and vapors together is the equivalent of their separate withdrawal in the patent, then Defendant uses the process described.

Subdivisions 4 to 7 and 17

No, in so far as the practice by Defendant of its Tube-and-Tank Process is concerned.

Subdivisions 11, 14 & 17

No, in so far as the practice by Defendant of the Burton Process is concerned.

Interrogatory XLIV

Adams Patent #1,433,519, of October 24, 1922

Subdivisions 3, 6-9 & 11

Defendant adopts as its answer to these Subdivisions, the answer of Defendant, Standard Oil Company (Indiana) [fol. 20] in so far as said answer refers to the use of Shell Radiator and Tube Radiator Type of Equipment, in the practice of the Burton Process by Defendant.

Subdivision 10

In some of its practice, Defendant operates in its Tube-and-Tank Process, two soaking drums in parallel from the

same heating coil and equalizes pressure in the two drums. In this practice, if, for the purposes of the invention of the Adams patent, the two soakers are the equivalent of two converters C of the patent, then Defendant uses the process described.

Subdivisions 14-25

No.

Interrogatory LIII

Hall Patent #1,175,909, of March 14, 1916

Subdivision 9 (Claim 9 of the Patent)

In the operation of Defendant's Tube-and-Tank Process, there is at all times a flowing mixture of gases and vapors in the soaking drums, and there is under most conditions of operation also suspended carbon in this flowing mixture. The Defendant releases pressure from 250 or 350 pounds in the soakers to about 50 pounds in the vapor separator. If this practice is for the purposes of the Hall invention the equivalent of the release of pressure into vessel "D," then Defendant uses this process.

Subdivision 18

For a full description of the range of temperatures, pressures, stocks, and conversion capacities of Defendant's Process, see answer to Interrogatory LXV. Under some of those operating conditions used commercially by the Defendant, there is material vaporization of the oil products in the heating coil, the extent of such vaporization being dependent upon the temperature-pressure relationship, the character of the stock charged, and the amount of conversion to lighter products and gas which takes place within the system.

If for the purposes of the Hall invention a temperature of 810° F. to 875° F. is the equivalent of the temperature of 600° C. described by Hall, and the corresponding pres- [fol. 21] sure condition of about 250 or 350 pounds the equivalent of five atmospheres as described by Hall, then Defendant uses the process in its regular Tube-and-Tank operation.

Used to a limited extent in preliminary commercial operations of a high temperature Tube-and-Tank process.

NOTE.—The apparent discrepancy between the temperature of 600° C. used in the second paragraph of this answer and the temperature of 500° C. specified in Claim 18 of the Hall patent is explained by the fact that the Defendant is advised that it should base its answers on the operation to which the claim refers, in which operation in the Hall patent in question a temperature of 600° C. is specified. Under such advice of counsel, the Defendant can only answer Subdivision 18 of this Interrogatory in the manner in which it has answered it, and assumes that the Petitioner will realize that this is not a question of fact but one of the proper interpretation of the patent claims, concerning which the Defendant has no desire to enter into any controversy in these Interrogatories.

Interrogatory LVI

Hall Patent #1,242,795, of October 9, 1917

Subdivision 1

Defendant condenses fractionally at a temperature of about 400° F. in the top of its vapor separators, and then condenses finally the vapors passing this zone. If this step be the equivalent for the purposes of the Hall invention of the steps of cooling conducted in B and B', and if the conditions recited in Answer to Interrogatory LIII, Subdivisions 10 and 18 are also remembered, the Defendant is to that extent using the process described.

Subdivision 3

Same as Subdivision 1, with the additional point that Defendant uses a pressure of about 50 pounds in lieu of the pressure of about 70 pounds described.

Subdivisions 8 and 9

The crude naphtha distillate, representing the condensate from the vapors leaving the top of Defendant's vapor separator, when the cracking apparatus is operating on Mid-

[fol. 22] Continent gas oil has been carefully examined for the purposes of providing further information with respect to these Interrogatories, with the following results:

A sample of motor fuel prepared in the laboratory from an authentic and uncontaminated sample of distillate produced in one of Defendant's cracking coils when operating upon Mid-Continent gas oil was found to have the following properties:

Specific gravity of .76.

Engler distillation inspection as follows:

Initial boiling point, 133° F.
20% off at 221° F.
90½% off at 392° F.
Final, 426° F.
Bromine number, 31½.
Carbon, 85.6.
Hydrogen, 14.2.

The product above described was prepared from the crude distillate by standard laboratory treatment with approximately 6# per 50-gallon barrel of 66° sulphuric acid, followed by neutralization and redistillation. The crude naphtha distillate from which this gasoline was prepared, and which constituted the product subjected to the treatment referred to in Subdivisions 8 and 9, was made up of approximately 75% of the motor fuel, the balance being heavier products of cracking of Mid-Continent gas oil, the whole being admixed in the apparatus up to and during condensation with upwards of 5% by weight of cracked hydrocarbon gases, of a specific gravity of approximately 1, when dry of their gasoline content and containing considerable proportions of saturated and unsaturated hydrocarbons containing three or more carbon atoms.

The foregoing constitutes a description of so much of Defendant's process as is referred to in the terms of Subdivisions 8 and 9. If, for the purpose of the Hall invention, the products produced in Defendant's conversion operation are the equivalent of those which would be produced by the invention described in the Hall patent and if, for the purposes of the Hall invention, the operation described as carried out on the material described is the equivalent of the operaton described in the Hall specification and carried

out on the material described therein, then Defendant uses the improvements of Subdivisions 8 and 9.

Defendant has knowledge that under conditions of operation other than those obtaining with the sample as taken, it [fol. 23] produces a considerably higher proportion of unsaturated constituents, and also a higher proportion of gases, but has not on record any corresponding detailed examination of an authentic pure sample of product from operation of its Tube-and-Tank Process.

Answers to Supplemental Interrogatories Relative to Subdivisions 8 and 9*.

1. Defendant has no evidence of any chemical affixation of gases and liquids at this stage of its process except that mixtures of the type which Defendant here produces depart markedly from Raoult's Law in the direction of showing a lower vapor pressure than can be accounted for by the general law.

2. This portion of Defendant's apparatus is designed and operated solely on the basis of its physical efficiency as a rectifying, heat exchanging and condensation apparatus.

3. Defendant does not know whether the departure from Raoult's Law referred to, is solely from physical reasons or involves molecular changes.

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*Supplemental Interrogatories 8 and 9 are contained in letter of August 4, 1925 to F. A. Howard from William J. Donovan, Assistant to the Attorney General, and are as follows:

1. "State whether or not Defendant is aware of any chemical affixation of gases and liquids and also

2. "Whether the mixture of gases and liquids are held under pressure and at a temperature of 200° C. for any further purpose, or for any further length of time than to get them into the condenser and condense them.

3. "If the Defendant does not know whether there is any chemical affixation of the gases and liquids, it should so state."

Subdivisions 3, 8 & 9

Defendant adopts as its answers to Subdivisions 3, 8 & 9, the supplemental answers of Defendant, Standard Oil Company (Indiana) in so far as these answers relate to use of Tube and Shell Type of Equipment, in the Burton Process as practiced by Defendant.

[fol. 24] Interrogatory LVII

Hall Patent #1,242,796, of October 9, 1917

Subdivisions 1, 2 & 4 (Claims 1, 2 & 4 of the Patent)

Subdivisions 1 & 2

No.

Subdivision 4

Yes, assuming that Defendant's pressure of about 50 pounds is equivalent for the purposes of the Hall invention, to the pressure of about 70 pounds, and that the conversion products of the Defendant are the equivalent of Hall's.

Subdivision 16

Same as Subdivision 4, with the further assumption that the cracking temperature of 810° F. to 875° F. regularly used by the Defendant is the equivalent of the temperature 500° C. to 650° C. named by Hall.

Subdivision 21

Same as Subdivision 4.

Interrogatory LXV

Cross Patent #1,423,500, of July 18, 1922

Subdivisions 1-15

The Defendant's mechanical construction and operation corresponds to that defined in the Subdivisions of this Interrogatory. The difference, in so far as these Interrogatories are concerned, resides solely in the conditions of the

operating procedure as to temperature, pressure, character of oil fed, and conversion to gasoline, which conditions in turn determine the relative percentages and character of vapor, liquid and gas in the various parts of the system.

Specifically, Defendant has present at all times in the cracking zone of its system, methane and hydrogen, which have critical temperatures below those given herein.

[fol. 25] In the operation of the Defendant's process, the stocks used ranged from kerosene or heavy naphtha up to the heaviest common crude oils. The corresponding temperature range used in the coils is from about 875° to about 810° at the outlet of the heating coil, and about 800° to about 720° at the outlet of the soaking drums. The amount of gasoline produced is from about 30% to about 10%. The pressure is about 250 to 350 pounds. If under any of these conditions the proportions of vapor and liquid in the coil and soaking drum are for the purposes of the Cross invention the equivalent of those produced with a Kansas gas oil at a temperature of about 750° F. and a pressure of about 750 pounds, then the Defendant uses the process of the claims to that extent.

Interrogatory LXVII

Chamberlain Patent #1,221,790, of April 3, 1917

Subdivisions 1-25, Claims 1-25 of the Patent

Defendant adopts as its answer to all the subdivisions, the answers of the Defendant, Standard Oil Company (Indiana) as set forth in their answers to the Interrogatories, as filed on or about May 8, 1925.

Interrogatory LXX

Hall Patent #1,239,099, of September 4, 1917

Subdivisions 16-45 (Claims 1-30 of the Patent)

Hall Patent #1,239,100, of September 4, 1917

Subdivisions 46-64 (Claims 1-19 of the Patent)

For the purposes of the present proceeding, the Defendant does not allege that it has in the past formed or is at

the present time forming in its commercial operations, the products of the Hall patents, as defined in the several subdivisions of this Interrogatory.

Interrogatory LXXVI

Burton Patent, #1,167,884, of January 11, 1916

[fol. 26] Claim 1 of Patent

Yes.

Interrogatory LXXVII

Claim 2 of Burton Patent #1,167,884

Yes.

Interrogatory LXXVIII

Claim 3 of Burton Patent #1,167,884

Yes.

ANSWERS OF THE DEFENDANT STANDARD OIL COMPANY (INDIANA) TO PETITIONER'S INTERROGATORIES FILED APRIL 3RD, 1925

Answer to Interrogatories #1-68. This defendant is advised that the several subdivisions of Interrogatories numbered one (1) to sixty-eight (68) inclusive, are copies of claims of various patents, the several interrogatories and their subdivisions being identified with the several patents and their respective claims, as shown in the attached chart, No. 1.

By way of general answer to all of said interrogatories, this defendant says that it has, or has employed, in its several plants, pressure stills of six (6) different types, which, for the purpose of convenience, are colloquially termed "Shell Radiator," "Shell Bubble Tower," "Tube Radiator," "Tube Bubble Tower," "High Pressure," and "Continuous," the several types being indicated in Chart No. 1 and elsewhere by the abbreviations "S. R.," "S. B. T.," "T. R.," "T. B. T.," "H. P." and "Cont." respectively.

The number of stills of each type which this defendant has employed has varied from time to time, and sometimes stills of one type have been changed to stills of another type. To indicate in the simplest way the number of stills of each type at different times, defendant submits Chart No. 2, which is a graph indicating the number of stills of each type at each date. The dates indicated are those at which the particular construction work involved was closed on the books. In most cases the construction work on a group of stills was in actual progress for many months prior to the date of finishing the building and closing the account, and as a general practice stills went into use as soon as they were ready to operate, regardless of the fact that other stills under construction on the same appropriation were still being built. The dates indicated by the graph are, however, approximately correct for all purposes which are believed to be material to this case and to give the data with any more particularity would involve extreme complications and might be impossible.

As to the two groups of stills which are classified as "shell radiator" and "tube radiator," this defendant says the development of its overhead equipment in stills of this type was substantially as set forth below.

At the outset of its cracking operations this defendant [fol. 27] used overhead or reflux equipment substantially as illustrated in the Humphreys patent No. 1,119,700. Subsequently this defendant began to employ more and more overhead equipment. The first step in the direction of enlarging the overhead was to add to the Humphreys equipment pipes like those shown at 13 and 14 in the Moore patent No. 1,130,318, but without the radiator. This equipment was generally termed in the works "pigtail overhead" and was of various forms and lengths. Subsequently the Moore radiator was added to the equipment, originally being employed with the pigtail as illustrated in the Moore patent. Shortly thereafter, however, the pigtail pipe was eliminated and the number of pipes in the radiators correspondingly increased so that the construction became one which could be diagrammatically illustrated by that part of the drawings in the Humphreys and Burton patent No. 1,343,674, which illustrates the pipes in the overhead. In Chart No. 1 all of these successive forms of overhead consisting of piping have been grouped under the two classes of radi-tor stills above referred to. The

applicaton of the several claims would be the same to all of these structures excepting the application of the Moore patent, which fits only the specific radiator construction. From about the filing date of the Moore patent, October, 1914, this defendant's overhead was gradually shifted to the more strict radiator type, and today all the stills listed in Chart No. 1 as radiator stills are so equipped. It is impossible for this defendant to ascertain the exact time the older pigtail equipment was in each case replaced with radiator equipment, because this did not all occur at once but was spread over a long period, the time of the shift differing in different plants. Broadly speaking, all the equipment of the stills listed as radiator stills was pigtail equipment up to sometime in 1914, and for some years last past it has all been of the more technical radiator type.

The defendant has under construction a battery of continuous stills which are nearly ready to run but which do not appear in Chart No. 2.

As to this defendant's licensees, the practice has been for some representative of the licensee or prospective licensee to visit one or another of defendant's plants, and examine the installation there and discuss the operation of the different types of equipment with its operators, obtaining such information as seemed applicable to the particular raw material and market conditions of the indi- [fol. 28] vidual licensee. The licensee was then furnished with blue prints of defendant's Shell Radiator stills and Tube Radiator stills of the type then in use by this defendant, with the latest modifications and improvements, and made the installation according to its best judgment. This defendant has not attempted to dictate to its licensees the type or style of equipment which they should install, but has left them free to select anything used by this defendant or covered by any or all of defendant's patents. In general the licensees have substantially copied this defendant's Shell Radiator or Tube Radiator types of equipment, but, in many cases, have added improvements or modifications of their own, and, in some cases, have extensively reorganized and remodeled the whole plan. This defendant requires no reports from its licensees as to the number of their stills or the kind installed, and has no definite information excepting as some of this defendant's representatives have occasionally observed from licensee's

plants in operation or have casually learned by conferences the types of equipment in use.

This defendant is advised that all of the foregoing interrogatories call for opinions or legal interpretations of patent claims and not for definite matters of fact concerning which this defendant has or can have certain knowledge. This defendant has no means of answering the interrogatories except upon the advice of counsel skilled in such matters and upon whose advice this defendant is accustomed to rely. This defendant is advised by its patent Counsel that of the large number of claims inquired about there are a considerable number concerning which it is possible to form a very definite opinion that they are not either at all or in some particular type of still; and that there are a considerable number concerning which it is possible to form a very definite opinion that they are used. This defendant is advised, however, that there are a large number of claims inquired about, the interpretation of which would be subject to reasonable dispute, but which have a sufficient prima facie similarity to defendant's operations, or defendant's practice, or apparatus, to justify honest and competent patent counsel in claiming infringement thereof by the several processes, apparatus', or practices, and bringing suits thereon, which suits, if brought, would be difficult and expensive to defendant, and the outcome of which could not be predicted with certainty until a final decision by a court of last resort.

This defendant has, therefore, segregated the claims in- [fol. 29] quired about into three (3) groups,—those which aparently not used, those which are apparently used, and those which are threatening in the sense above stated, and in said group of threatening claims has included certain patents owned by it if of such debatable scope. In Chart No. 1 this defendant has applied the claims to each of the six types of stills and the processes therein operated, marking at the intersection of the verticle column indicating the character of the still, and the horizontal line indicating the number of the claim and the subdivision of the interrogatory "U" if the claim is apparently used, and "T" if it is apparently threatening to that particular type of equipment or the process therein operated, and has left the intersection blank in the cases where the claim is apparently not used.

Interrogatories one (1) to sixty-eight (68) inclusive are, therefore, answered as completely as is possible by the foregoing and by Charts No. 1 and 2, excepting that defendant's answer to Interrogatory 67 requires further explanation.

Answer to Interrogatory #67. This defendant is advised that Interrogatory 67 incorporates the claims of the Chamberlain patent. Certain of the claims of this patent which are indicated appropriately on Chart No. 1 are apparently not used by this defendant. Other claims also indicated and which are claims No. 1 to 6, inclusive, 9, 10 and 25, apparently depend upon the particular characteristics of the charging stock. This defendant has no record of inspections of its charging stock along the lines specified in these claims, and, having had a license to employ these claims if and when it chose, has had no reason for making inspections along the lines specified in these claims. This defendant is, therefore, wholly unable to say positively that it has or has not employed the subject matter of the claims, and, if so, to what extent, but defendant's best judgment is, having in mind the manner in which its charging stock is made at its several plants, that in all probability it has employed at various times the subject matter of these claims. If and when the subject matter of these claims has been employed, such employment would naturally be in all the Shell and Tube stills at the particular plant at the particular time. In all probability the subject matter of these claims has not been employed in the High Pressure or the Continuous stills.

Answer to Interrogatory #69. Yes.

Answer to Interrogatory #70. This defendant is advised that the several subdivisions of this interrogatory are the claims of several of five patents.

[fol. 30] This defendant is advised by its counsel that subdivisions 1 to 15 inclusive, are correspondingly numbered claims of the Ellis Patent No. 1,318,060, granted 10/7/19.

This defendant is advised that all the claims of said patent are threatening, as hereinafter defined, to all of defendant's cracked product.

This defendant is advised that subdivisions 16 to 45, inclusive, are claims 1 to 30 of the Hall Patent No. 1,239,099, granted 9/4/17; that subdivisions 46 to 64, inclusive, are claims 1 to 19, inclusive of the Hall Patent No. 1,239,100, granted 9/4/17; that subdivisions 65 and 66 are claims 13

and 14 of the Ellis Patent No. 1,396,999, granted 11/15/21, and that subdivisions 67 and 68 are claims from the Clark Patent No. 1,413,260, granted 4/18/22.

This defendant is advised that none of its product is covered by any of the claims corresponding to subdivisions 16 to 68, inclusive.

Answer to Interrogatories #71, #72 and #73. Up to about August, 1920, this defendant treated its cracked product containing unsaturated bodies with 66° Be'. acid. At occasional intervals the acid used may have been, and probably was, fresh commercial, acid of full strength. However, practically all of defendant's treating prior to that date was done with restored acid of the gravity of 66° Be'., which acid is materially weaker than fresh acid by reason of the presence in it of various substances, but not water. Since the above date the major part of this defendant's treating in its various plants has been with 75% acid. However, from time to time plant exigencies have required that at certain periods the acid be brought up to 66° Be'. strength, after which it is again allowed to become diluted. It is entirely impossible to state with any exactness the percentage of defendant's cracked products which have been treated with 66° acid and what percentage with 75% acid, but most of defendant's treating has been with dilute acid since the above date.

Answer to Interrogatory #74. On the advice of counsel as hereinbefore defined, this defendant says that it believes that it probably does practice the process of Interrogatory #74.

Answer to Interrogatory # 75. The characteristics of defendant's treating acid has been fully set forth in answer to Interrogatories #71, #72, and #73 above. Both the strength and the gravity of the acid may have varied from time to time by reason of (first), varying quantities of fresh [fol. 31] acid used to make up losses; (second), the operation of its acid works, (which is entirely an acid restoring plant); and (third), climatic conditions which have at times dictated the strength of the acid.

Answer to Interrogatories #76 and #77. Yes.

Answer to Interrogatory # 78. This defendant at one time made a considerable amount of the specific oil covered by this interrogatory for the market. It is not now manu-

facturing said oil but will should a market demand again arise.

Answer to Interrogatory # 79. Defendant has indicated in Chart No. 1, and is advised, that it has not used the processes of the Palmer patents, #1,313,099, and #1,360,973, and is advised that it, in all probability, has used the process of patent #1,187,380, (which is indicated as "threatening" in Chart No. 1), in the following manner and to the following extent.

In the beginning of a run, on this defendant's Tube and Shell and High Pressure stills, this defendant charges the stills nearly full with its charging stock and heats the stills to a temperature sufficient to drive off water and a small quantity of light vapor while the still is at atmospheric pressure. This dehydration being completed, it closes up its stills and admits gas from an outside source sufficient to markedly raise the pressure therein and to inhibit further boiling. Defendant then digests the contents of its stills for a period of several hours at a gradually rising temperature, the rise, however, being slower at the end of the digestion and usually there being no rise during the last hour or so of the digestion, the digestion being carried to such an extent that the boiling point of the stock is reduced from 40 to 60 degrees as compared with its boiling point after the dehydration step. This digestion is sufficient that, on inspection of the material in the still, it will be found that approximately half or more of the stock in the still will distill over at a lower temperature than would a like percentage of the stock in the still before the digestion commenced.

When the Palmer patent issued, this defendant was threatened with suit thereon by Palmer, the charge being that during this period of digestion the defendant so modified its stock as to bring the operation within the Palmer patent. This defendant caused the validity and scope of the Palmer patent to be investigated and was advised that there was much basis for the charge then made by Palmer, and that his claim ought to be adjusted, and this defendant, [fol. 32] therefore, bought the Palmer patents from Palmer for the sum of seventy thousand dollars ($70,000.00).

Answer to Interrogatories #82 and #83. This defendant does not now recall any agreement or contract within the terms of these interrogatories.

GENERAL NOTE.—This defendant has employed from time to time a great many variants of its normal process of the six types herein identified. These operations have in general been what would be termed "experimental," but this defendant's experimentation has frequently, if not usually, been carried on, at least in part, by modifying one or more of its commercial stills and operating them in competition with stills of defendant's more usual types. There have doubtless been several hundred variants of this kind. No effort has been made to apply any of the numerous claims to these occasional and relatively temporary operations. In some instances, the use of some particular expedient has been so general as to justify marking it "used" in the charts, and in those cases where the expedient was subsequently abandoned, the indication is made by affixing a subscript "a" to the character. In other cases, notably, for example, in the case of Claims 1 and 2 of the Burton and Clark patent, ($1,448,254), the use of the particular still has been occasional but is not uniform. In such cases a subscript "s" is affixed to the proper mark on the chart. In general, however, experimental work, even though the products were commercially sold, has not been covered by the foregoing answers, or any of them.

Standard Oil Company (Indiana).

Standard Oil Company (Indiana)

Chart No. 1

Interrogatory No.	Claim No.	Patent No.	Inventor	S. R.	S. B. T.	T. R.	T. B. T.	H. P.	Cont.
1	1-7	954575	Lang	..	..	..	..	..	..
2	1-2	1049667	Burton	U	U	U	U	T	T
3	1-2	1055707	Burton	U	U	U	U	U	U
4	1-2	1105961	Burton	U	U	U	U	T	T
5	1-2	1112113	Burton	..	..	..	..	..	..
6	1	1119496	Clarke	..	..	U	U	U	..
	2-3	.....	.....	..	..	U	U	..	..
7	1-2	1119700	Humphreys	U	U	U	U	U	U
8	1-5	1122002	Humphreys	U	U	..	..	..	..
9	1-4	1122003	Humphreys	U	U	..	..	..	..
10	1-19	1122220	Rogers & Cooke	Ua	..	Ua	..	..	..
11	1-6	1129034	Clarke	U	U	U	U	U	..
12	1	1130318	Moore	U	..	U	..	..	..
13	1-4	1132163	Clarke	U	U	U	U	U	..
14	1-3	1160689	Burton	U	U	U	U	T	U
15	1-3	1230065	Cash	Ua	..	..	..	..	..
16	1-3	1343674	Humphreys & Burton	..	..	..	..	..	..
17	1-7	1392584	Lewis & Cooke	..	U	..	U	..	U
18	1	1448254	Burton & Clarke	Us	Us	Us	Us	Ts	..
	2	.....	.....	Us	Us	Us	Us	Ts	..
	3	.....	.....	..	..	..	..	..	T
	4	.....	.....	..	..	..	..	..	T
	5	.....	.....	..	..	..	..	U	U
	6	.....	.....	..	..	..	..	U	U
19	1-4	1388514	Clarke	Us	Us	U	U	U	..
20	1-3	1187380	Palmer	T	T	T	T	T	..
21	1-3	1313009	Palmer	..	..	..	..	..	..

Standard Oil Company (Indiana)—Continued

Interrogatory No.	Claim No.	Patent No.	Inventor	S. R.	S. B. T.	T. R.	T. B. T.	H. P.	Cont.
22	1-4	1360973	Palmer	..	..	..	..	..	..
23	1-6	1187874	Wells	..	..	..	..	..	..
24	1-10	1232454	Wells	..	..	..	..	..	..
25	1-3	1248225	Wells	..	..	..	..	..	..
26	1-6	1216071	Ellis	..	..	..	..	..	..
27	1-9	1249278	Ellis	..	..	..	..	..	..
28	1-28	1317868	Ellis	..	..	..	..	..	..
29	1-11	1341975	Ellis	..	..	..	..	..	..
30	1-12	1396999	Ellis	..	..	..	..	..	..
31	1	1415232	Ellis	..	..	..	..	..	U
	2	.....	.....	..	..	..	..	..	..
	3	.....	.....	..	..	..	..	..	..
	4	.....	.....	..	..	..	..	..	U
	5	.....	.....	..	..	..	..	..	..
	6	.....	.....	..	..	..	..	..	U
	7	.....	.....	..	..	..	..	..	..
	8	.....	.....	..	..	..	..	..	U
	9	.....	.....	..	..	..	..	..	..
	10	.....	.....	..	..	..	..	..	..
32	1-8	1405286	Clarke	..	..	..	..	..	..
33	1	1410797	Clarke	..	..	..	..	..	T
	2-4	.....	.....	..	..	..	..	..	..
34	1-6	1413899	Clarke	..	..	..	..	..	..
35	1-7	1478102	Clarke et al	..	..	..	..	..	..
36	1	1320354	Adams	..	..	..	..	..	..
	2	.....	.....	..	..	..	..	..	..
	3	.....	.....	..	..	..	..	..	..
	4	.....	.....	..	..	..	..	..	..
	5	.....	.....	..	..	..	..	..	..

[fol. 33]

	6			..	..	..	..	..	..
	7			..	..	..	..	..	..
	8			..	..	..	..	..	..
	9			Ta	T	T	T	T	T
	10			..	..	..	..	..	..
	11			..	..	..	..	..	..
	12			..	..	..	..	..	..
	13			..	..	U	U	U	U
	14			..	..	U	U	U	U
	15			T	T	U	T	T	T
	16			..	..	T	T	T	T
	17			T	T	T	T	U	U
	18			..	..	..	..	U	U
	19			..	..	..	..	..	U
	20			..	..	..	..	..	..
	21			..	..	..	..	..	..
	22			..	..	..	..	..	..
	23			T	T	T	T	T	T
	24			..	..	T	T	..	..
	25			..	..	..	..	..	..
	26			..	..	..	..	..	..
	27			..	..	..	..	..	..
	28			..	..	..	..	..	..
37	1-5	1320726	Adams	..	..	..	..	..	..
	6			..	..	..	..	..	U
	7			..	..	..	..	..	..
	8-11			..	..	..	..	..	..
38	1	1320727	Adams	..	..	..	..	..	..
	2			..	..	T	T	T	T
	3			..	..	T	T	T	T
	4			..	..	..	..	..	..
	5			..	..	..	..	..	..
	6			..	..	..	..	..	..
	7			..	..	..	..	..	..

Standard Oil Company (Indiana)—Continued

Interrogatory No.	Claim No.	Patent No.	Inventor	S. R.	S. B. T.	T. R.	T. B. T.	H. P.	Cont.
	8-24			..	..	..	..	..	..
	25			..	..	..	..	..	T
	26			..	..	..	..	..	..
	27			..	..	..	..	..	..
	28			..	..	..	..	..	..
30	1	1327263	Adams	Ta	Ta	T	T	T	T
	2			Ta	Ta	T	T	T	T
	3			..	..	..	..	..	..
	4			Ta	Ta	T	T	T	T
	5			Ta	Ta	T	T	T	T
	6			..	..	T	T	T	T
39	7			..	..	T	T	T	T
	8			..	..	U	U	U	U
	9			..	..	T	T	T	T
	10			..	..	..	..	..	T
	11			..	..	T	T	T	T
	12			..	..	..	..	..	..
	13			..	..	..	..	..	T
	14			..	..	T	T	T	T
	15, 17, 18			..	..	T	T	T	T
	16-9-23			..	..	T	T	T	T
	24			Ta	Ta	T	T	T	T
	25			T	T	T	T	T	T
	26			T	T	T	T	T	T
	27			T	T	T	T	T	T
	28			T	T	T	T	T	T
	29			..	..	..	..	..	..
	30			..	..	..	..	..	U
	31			..	..	..	..	..	..
40	1-0	1428311	Adams						

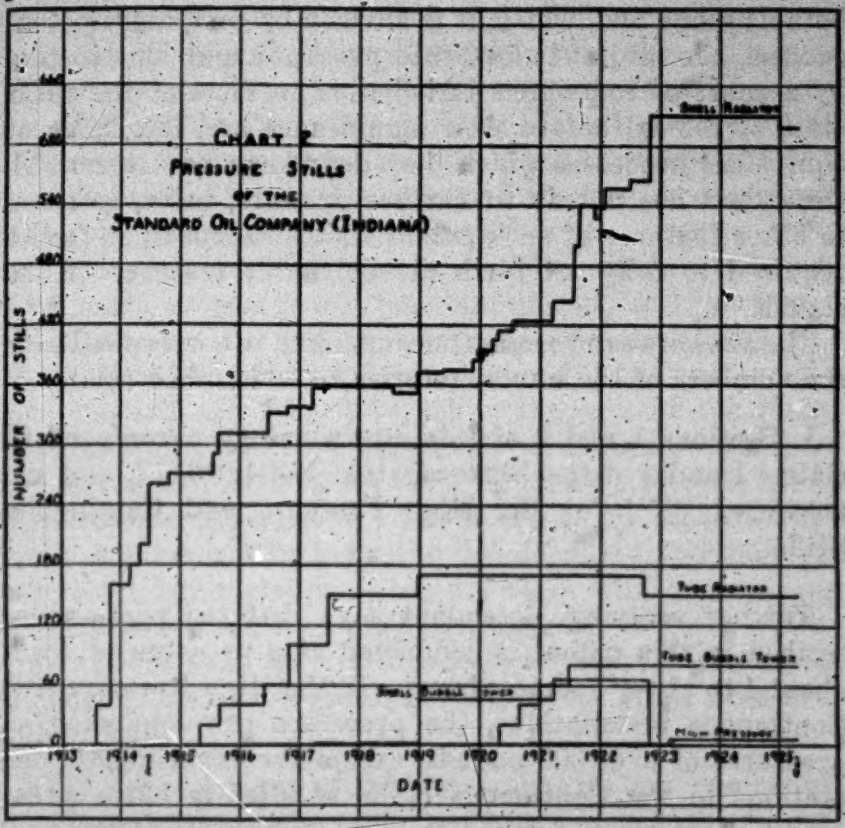
[fol. 34]

41	1-7	128312	Adams	..	..	..	..	..	..	..
42	1-9	1428338	Manley	..	..	..	..	..	..	..
43	1-11	1428339	Manley	..	..	..	..	..	..	..
44	1	1433519	Adams	..	..	..	..	..	..	U
	2	.....		..	..	..	..	..	..	U
	3	.....		Ta	Ta	T	T	T	T	T
	4	.....		..	..	..	..	..	..	T
	5	.....		..	..	..	..	..	..	T
	6	.....		T	T	T	T	T	T	U
	7	.....		T	T	T	T	T	T	U
	8	.....		Ta	Ta	T	T	T	T	U
	9	.....		Ta	Ta	T	T	T	T	U
	10	.....		U	U	U	T	U	T	T
	11	.....		T	T	T	T	T	U	..
	12-17	.....		..	..	..	..	..	U	..
	18	.....		..	..	..	..	..	T	..
	19	.....		..	..	..	..	..	..	..
	20	.....		..	..	..	..	..	..	..
	21	.....		..	..	..	..	..	U	..
	22	.....		..	..	..	..	..	U	..
	23	.....		..	..	..	..	..	U	..
	24	.....		..	..	..	..	..	..	..
	25	.....		..	..	..	..	..	U	..
	26	.....		..	..	..	..	..	T	..
	27	.....		..	..	..	..	..	..	..
	28	.....		..	..	..	..	..	..	..
45	1-9	1445281	Adams	..	..	..	..	..	..	..
46	1-9	1455376	Adams	..	..	..	..	..	..	..
47	1-14	1455376	Adams	..	..	..	..	..	..	..
48	1-3, 13-15, 17	1461017	Adams	..	..	..	..	..	..	..
	4, 5, 7-9, 16, 20-22,	.....		..	..	..	..	..	T	..
	6, 10-12, 18, 19	.....		..	..	..	..	..	..	..
49	1-6	1462143	Manley	..	..	..	..	..	..	..
	7-8	.....		..	..	..	..	..	U	..

Standard Oil Company (Indiana)—Continued

Interrogatory No.	Claim No.	Patent No.	Inventor	S. R.	S. B. T.	T. R.	T. B. T.	H. P.	Cont.
50	1-31	1462677	Adams	..	..	..	..	..	..
	32	.....	.....	..	..	..	..	..	T
51	1-22	1462678	Adams	..	..	..	..	..	..
	23	.....	.....	..	..	..	..	..	T
52	1-5	1477860	Adams	..	..	..	..	..	..
53	1-18	1175909	Hall	..	..	..	..	..	..
54	1-17	1175910	Hall	..	..	..	..	..	..
55	1-11	1194289	Hall	..	..	..	..	..	..
56	3, 8, and 9 Others	1242795	Hall	T	T	T	T	T	T
		.....	.....	..	..	..	..	..	..
57	1-24	1242796	Hall	..	..	..	..	..	..
58	1-7	1285136	Hall	..	..	..	..	..	..
59	1-2	1261930	Hall	..	..	..	..	..	..
60	1-6	1437045	De Florez	..	..	..	..	..	..
61	1-3	1506877	Adams	..	..	..	..	..	..
62	1-13	1506878	Adams	..	..	..	..	..	..
63	1-6	1208312	Cross	..	..	..	..	..	..
64	1	1326851	Cross	..	..	..	..	..	..
65	1-15	1428500	Cross	..	..	..	..	..	..
66	1	1437229	Cross	..	..	..	..	..	..
67	1-6	1221790	Chamberlain	Probably at Times					
	7-8	.....	.....	..	..	..	..	..	..
	9-10	.....	.....	Possibly at Times					
	11-24	.....	.....	..	..	..	..	..	..
	25	.....	.....	Possibly at Times					
68	1-9	1418260	Clarke	..	..	..	..	..	..

[fol. 35]



[fol. 36] Further Answers of the Defendant Standard Oil Company (Indiana) to Petitioner's Interrogatories Filed April 3, 1925

The following is a supplemental and further reply of the Defendant, Standard Oil Company (Indiana), to petitioner's interrogatories filed April 3, 1925, and is directed to a further explanation of the answers indicated by the term "T" in the original reply of the Standard Oil Company of Indiana.

By way of general supplemental answer with respect to those sections of interrogatories answered "T" as to one or more forms of defendant's installations, defendant says:

Defendant has, in further answering such sections of interrogatories, set forth, to the best of its knowledge, information, and belief, the facts relative to its own operations and apparatus bearing upon the features in the pat-

ent claims making up the interrogatories which are of debatable scope and, which, it is advised by competent patent counsel, are subject to final interpretation and construction by a court of competent jurisdiction in view of the prior state of the art before their significance and the range of equivalent processes which they define can be determined. Defendant has not, in its further answers, infra, referred to other features of such patent claims except in so far as required to fully set forth the debatable features of the claims.

The answers are hereinafter numbered to correspond with the numbers of the interrogatories to which they relate.

I. Sections 1 and 2 of this interrogatory correspond to claims 1 and 2 of the Burton patent No. 1,049,667, and are answered "T" for the High Pressure and Continuous Stills.

Further replying, defendant says that the process described in this patent is conducted at a pressure of from about 4 to about 5 atmospheres. In the High Pressure and Continuous installations, the processes are conducted at pressures of over 300 pounds, except for experimental operations in the Continuous Stills at slightly lower pressures. If this is construed to be an equivalent of the process of the patent, these sections of this interrogatory are used in the processes of thee installations; if not so construed, then they are not used.

IV. Sections 1 to 2 of this interrogatory correspond to claims 1 and 2 of Burton patent No. 1,105,961, and are answered "T" for the High Pressure and Continuous Stills.

Further answering both sections of this interrogatory, [fol. 37] defendant says that the process of this patent is described as including a pressure distillation step conducted at a pressure of from about 4 to 5 atmospheres. The processes of the High Pressure and Continuous installations are conducted at pressures exceeding 300 pounds. If this is construed to be an equivalent of the process described in the patent, the processes of these claims are used in the High Pressure and Continuous Stills; if not so construed, they are unused.

XIV. The three sections of this interrogatory are the three claims of Burton patent No. 1,160,689. They are answered "T" for the High Pressure Stills.

Further answering, this defendant says that the construction employed in connection with the High Pressure Stills is the same as that shown and described in the patent for use in connection with stills operating the process described in Burton patent No. 1,049,667, and is the same as that used in the various shell and tube still operations. Owing to the much greater pressures obtaining in the High Pressure Stills and the high velocity of escaping vapors resulting when the safety valve operates, the thermal conditions existing are very different in the case of the High Pressure Stills, and it is impossible to determine whether they correspond to those set forth in patent 1,160,689, without extensive experiment. The facts as to these conditions are not now fully known to this defendant, but may be such as to bring the resulting oper-tion within the scope of these claims, as they may be construed in view of the prior art; in such case, the process of each of the three sections of this interrogatory is used in the High Pressure Stills.

XVII. The sections of this interrogatory are numbered to correspond to the claims of the Burton and Clarke patent No. 1,448,254.

Sections 1 and 2 have been answered "Ts" for the High Pressure installations.

Further answering, defendant says that in the operation of the shell and tube types of stills, the feed stock or stock fed into the still during the run is sometimes lighter than the charging stock, or stock originally charged into the still. In the operation of the High Pressure Stills, the stock fed into the stills during the run is not lighter than the original charging stock; but may sometimes be lighter than the original charging stock has become at the stage of the distillation process at which feeding occurs. If this is construed to be an equivalent of the process described in the patent, the process of these claims is used; otherwise not. [fol. 38] Sections 3 and 4, corresponding to claims 3 and 4 of the patent, are answered "T" for the Continuous Stills.

Further answering, defendant says that the conditions in these installations probably correspond to the conditions described above in connection with the High Pressure Stills. The stock fed into the system in the operation as now carried on and commingling with the stock undergoing conversion is not lighter than that previously fed into the system; but that previously fed into the system may have become so changed in the conversion operation that the newly fed stock may be lighter. If this operation is construed to be an equivalent of the process described in the patent, the processes of claims 3 and 4 are used; otherwise not. The precise nature of this defendant's operations in this type of still has not yet been determined and defendant can consequently not, by information now available to it, make fuller or more definite answer to this interrogatory.

Defendant, further answering, says that its original answer should be amended as to sections 5 and 6 of this interrogatory by inserting "U" under the columns headed "H.P." in lines corresponding to said sections.

XX. The sections of this interrogatory correspond to the respective claims of the Palmer patent No. 1,187,380 and have been answered "T" for each of the Shell and Tube type installations and the High Pressure Stills.

Further answering, defendant refers to its original answer to interrogatory LXXIX and says also:

The Palmer process is a digestion process. The stock treated, as recited in the patent, is a residue obtained by the distillation of crude oil. The stock employed in defendant's Shell, Tube and High Pressure Stills is a distillate stock of lighter gravity than that of Palmer. The temperature disclosed as used in the Palmer patent are throughout lower than those which are employed in the installations above referred to, although, during the operation of said type of stills the temperature of the oil passes through the range described in the Palmer patent. The percentage of products formed in the process described in the Palmer patent is much larger than the percentage of products formed by digestion in said installations of this defendant. If, however, defendant's process is construed to be the equivalent of the process described in this patent, the processes of the three claims are used in defendant's Shell, Tube and High Pressure type stills.

[fol. 39] XXXIII. Section 1 of this interrogatory corresponds to claim 1 of Clark patent No. 1,410,797. It is answered "T" in connection with the Continuous Stills.

This defendant, further answering, says:

In the operation of these stills the practice is contemplated of taking off tar or bottoms from the stills and expanding to a lower pressure while hot, thereby forming a distillate product which may be supplied to the tank containing the stock from which oil is fed to the stills. Defendant's practice relative to the handling of tars and bottoms from the Continuous Stills is not yet fixed, and no practice corresponding to that of the patent is as yet in use.

Further answering, this defendant says that, of the interrogatories requiring additional answer, the following relate to certain Adams patents:

XXXVI; XXXVII; XXXVIII; XXXIX; XLIV; XLVIII; L; LI. This defendant further says that there are certain features present in each of these Adams patents, the claims of which form the sections of these interrogatories, and others which are present in some of all the claims of these Adams patents, although expressed in varying ways in certain of the claims, and defendant has hereinafter made general answer in connection with each such feature common to all of the Adams patents or to numerous claims thereof. Defendant has designated each such general answer by a letter, and in answer to sections of interrogatories in subsequent pages, has made such general answers parts of its specific answers by reference thereto by letter.

A

By way of general answer to all the above named interrogatories relative to the Adams patents, this defendant says that the specific temperatures of the surfaces with which the oil is brought in contact for the purpose of heating, as disclosed in each said patent, are believed to be somewhat higher than those which this defendant employs in its actual operations. Furthermore, the pressures which Adams discloses are indefinite and may be either lower or higher than those used by this defendant. Also, it is be-

lieved that in the actual operation of the processes specifically disclosed in the Adams patents, the oil will be subjected to cracking temperatures for a much shorter time than in this defendant's actual processes as operated, as there is a relatively rapid flow of oil through a [fol. 40] zone in which a relatively small body of oil is retained at a time. In general, in the case of the claims of the Adams patents answered "T," it is necessary before this defendant's processes can be held to infringe that, for the purpose of the particular claim in controversy, this defendant's temperatures, pressures and times of treatment shall be held to be the equivalent of those occuring in the Adams processes. To avoid the appearance of inconsistency in the answers, relative to these Adams claims, some few of which have been answered "U" instead of "T," this defendant says that it is advised that some of the features disclosed and claimed in the Adams patents are of such broad and fundamental novelty that its counsel believe that, in claims involving these particular features, defendant's temperatures, pressures and times of treatment should be held to be the equivalent because of the broad range to which Adams would be enttiled, whereas for the purpose of other claims, counsel is in considerable doubt.

B

By way of general answer to many of the interrogatories and sections thereof drawn from the Adams patents, this defendant says that the devices and methods thereof require that the communication from the body of oil undergoing conversion and evolving vapors to the condenser, or to and through the condenser, shall be open, or free and open, this feature being stated in varying terminology in such claims.

Further answering with respect to this feature, this defendant says that in each of the types of stills operated by it, devices are interposed between the heated body of oil evolving vapors and the condenser in which condensation takes place under pressure, these devices being so operated that a substantial proportion, varying from 75 to 95%, of the vapors evolved from the heated oil are prevented from passing to the condenser. As pointed out in its original answer to these interrogatories, this de-

fendant's operations and structures have at various times been modified in minor details, as a result of which the proportions of vapors prevented from passing to the condenser have been varied to greater or less extents, exact information as to which variations is not available and cannot now be secured without extensive research and experiment. Further, the operation of defendant's continuous still has but just begun, and all that is available [fol. 41] to this defendant with respect to this type of stills is that data calculable with varying degrees of accuracy from the dimensions of the parts of the device under the most probable conditions of operation. To the best of the knowledge, information, and belief of this defendant, the proportions of vapors evolved from the body of oil undergoing conversion which is prevented from passing to the condenser in its various types of operations are within the limits above set forth.

C

Many of the sections of the interrogatories relating to the Adams patents require that the vapors generated or evolved by the heated body of oil or serving to maintain pressure thereupon be condensed; and others require that the same, or that uniform pressure, or vapor pressure, be maintained from the body of oil, from which vapors are evolved, to the condenser, or to and through the condenser, and certain of these sections require that the vapor pressure so maintained be solely that of vapors evolved, or generated, by the body of oil, or that it be a self imposed vapor pressure resulting from such evolution, or generation, of vapors. Generally answering with respect to each and all such features, this defendant says that in each of its types of apparatus, the cracking body of oil is caused to evolve large quantities of vapors and relatively small quantities of gas. The vapors generated are insufficient and inadequate to maintain the pressure prevailing upon the cracking body of the liquid in and through the condenser as operated by defendant in each of its types of installations. The vapors and gas evolved from the cracking body of oil are, in each of defendant's apparatus, caused to pass into devices which prevent the passage of a substantial proportion of the vapors, the proportion of vapors thus prevented

from passing being, to the best of this defendant's information and belief, from 75 to 95 per cent. Defendant's devices have been modified in minor details of construction and operation at various times, and full facts and information as to the percentage of vapors prevented from passing in the High Pressure types of still and in the operation of the Continuous Stills are not available to this defendant at this time without extensive research and experiment, except as calculable from data and information available as to structure, taken with present and probable conditions of operation. This defendant is advised, however, that the [fol. 42] proportion of vapors prevented from passing to the final condenser in the Shell and Tube Types of Stills is within the limits above stated and that calculations from facts and data available to this defendant indicate that in the High Pressure and Continuous Types of installations, the percentage of vapors prevented from passing to the final condenser is likewise within the limits above set forth. As a result of this operation, the proportion of vapor in the mixture of vapor and gas reaching the condenser is greatly decreased, the ratio of gas to vapor then being from 4 to 5 times the ratio of gas and vapor in the vapor space of the still or chamber in which vapors are evolved, and condensation is caused to take place under conditions in which the vapors present are wholly inadequate to maintain the pressure, which is maintained largely by incondensible gas. In the condensers as operated by this defendant, the proportion of the total pressure due to vapors as the vapors and gases pass through the condenser drops to less than one twentieth of the total pressure in the case of the Shell and Tube Type Stills, and to less than one-fortieth of the total pressure in the case of the High Pressure and Continuous Stills. It is also true that in case of defendant's shell and tube type stills incondensible gas produced by other stills at times passes from a high pressure manifold into the condenser system of a still in order to aid in building up or maintaining the pressure therein.

D

Further answering, this defendant says that many of the claims of the Adams patents forming the sections of the

above enumerated interrogatories include features involving the supply of fresh oil or stock to be cracked, in widely varying terms; some requiring that there be a feed of oil to the body of oil undergoing conversion or the container therefor; or to specified portions thereof; others that the feed of oil shall be such as to maintain a particular level or quantity of oil in its container; others that the feed or oil shall be such as to maintain a particular level or quantity of oil in its container; others that the feed or supply of oil shall be continuous, and the like. With respect to such features, this defendant says that in its operations in its Tube and High Pressure stills it provides therein an initial charge of oil to be treated, and after this charge has been brought to conversion temperatures under pressure and [fol. 43] distillation has begun, there is fed into the still additional oil during a portion of the distillation operation. This feed of oil is stopped before distillation is discontinued, the latter continuing until the volume of residuum remaining in the still is somewhat less than the volume of oil originally placed therein. During the distillation operation no residuum is removed from the still. A similar operation was for some time conducted in this defendant's Shell type stills, but has been abandoned. In the High Pressure still operations, the oil fed into the still during distillation first reaches the manifold connecting the tubes to which direct heat is applied, through which tubes the oil is caused to circulate from and back to the main body of oil under treatment.

In its operation of its Continuous Stills this defendant feeds oil continuously through a pipe coil in a heating zone into a plurality of large vertical chambers so interconnected as to permit free flow of oil there through, the oil in these chambers being maintained at conversion temperatures by the application of mild heat. Oil or residuum is withdrawn from these chambers during the run.

XXXVI. The sections of this interrogatory correspond in number to the claims of the Adams patent No. 1,320,354.

Further answering, this defendant says:

The original answer to section 15 of this interrogatory is hereby changed from "T" in the columns headed "S. R." and "S. B. T." to "Ta."

Section 23 has been answered "T" for all types of installations.

In the process described in this Adams patent, heat is supplied by an internal electric heater and in the processes of defendant's stills it is supplied by the external firing of the outer surfaces or tubes containing the oil. If the processes of defendant's installations are construed to be equivalent in this feature and in those set forth in general answer "A" above to those of the process of the Adams patent, the process of this claim is used in each type of operation of this defendant.

Section 9 of this interrogatory has been answered "T" except for the Shell Type of stills and "Ta" for the Shell Radiator Stills. Section 15 has been answered "T" as to all installations and Section 16 has been answered "T" as to all installations except those of the Shell type. The further answer made above in connection with Section 23 applies also to these sections, and is made a part of this defendant's further answer thereto.

[fol. 44] Further answering, this defendant says that if its operations are construed to be the equivalents of those of the Adams patent of this interrogatory in the features set forth in connection with Section 23 above and in those set forth in its general answers "A", "B", "C" and "D" above, the process of Section 9 is used in all except the Shell types of Stills and used and abandoned in the Shell Radiator Type; that of Section 15 is used in all types except the Shell Stills and used and abandoned in the Shell Stills; and that of Section 16 is used in all except the Shell Types.

Further answering Sections 17 and 24:

The additional answer made above in connection with Section 23 is hereby made a part of defendant's further answer in connection with Section 17.

In the device of this Adams patent, the vapors passing from the chamber in which they are evolved are caused to travel through a chamber provided with a single baffle and having for its purpose the removal of heavy oil from the vapors. This defendant's operations have been described in general answer "B" above. If the processes of this defendant, operated in its various types of stills, are construed as equivalents of that of this Adams patent as to the feature involving the heating device referred to in con-

nection with Section 23 and those referred to in general answers "A" and "C," the processes of these claims are likewise used; that of 17 in all types of installations and that of 24 in all except the Shell Stills.

XXXVII. Section 7 of this interrogatory corresponds to claim 7 of the Adams patent 1,320,726, and has been answered "T" as applied to the Continuous type of still.

Further answering as to Section 7, this defendant says: in the process described in this Adams patent, a shallow, extended body of oil is connected by a short neck to a large unheated body of oil, and heat is applied to the shallow, extended and, in a sense, segregated body of oil just referred to. Oil is fed to this shallow, heated body of oil, the extended surface of which is subjected to local cracking temperatures. In the continuous installation of this defendant, oil is fed through an elongated conduit in a heating zone and discharged therefrom into an enlarged container. The heat applied while traveling through this conduit is sufficient to bring the oil to atleast a conversion temperature.

The claim further requires that self generated vapor pressure be maintained on the body of oil and on the vapors [fol. 45] issuing therefrom during condensation. In the process shown in the patent, all of the vapors issuing from the body of oil being treated are passed to the condenser, after passing through a device said to remove some heavy unconverted oils.

If the process of defendant's Continuous Stills is construed to be the equivalent of that disclosed in this Adams patent as to the features compared in the above paragraph and those set forth in general answers "A," "C" and "D", the process of this claim is used in the operation of the answers "A" and "C," the processes of these claims are Continuous Stills.

XXXVIII. The sections of this interrogatory correspond in number to the claims of the Adams patent 1,320,727. Further answering this interrogatory, defendant says:

Sections 2 and 4 of this interrogatory have been answered "T" with respect to each type of Tube Still operation, High Pressure Still operation and Continuous Still operation. In the apparatus of this patent, an oil container is provided which has a bottom portion forming an ex-

tended shallow layer of oil connected by a short neck to a larger, main body of oil. Heat is applied locally to the shallow extended portion of oil, but not the main body of oil. In the Tube Stills and High Pressure Stills of this defendant, the main body of oil is in a container largely protected from direct fire. A large number of inclined tubes pass through the fire box of the still and connect at each end with headers or manifolds communicating with the container for the large body of oil, so that communication permitting constant circulation of the oil is effected. By this circulation, the whole body of oil is gradually brought to cracking and converting temperature. In the Continuous Stills, the oil is caused to flow from a source of supply continuously through a long tube subjected to external heat and from this tube discharges into large containers; in which a body of oil is likewise maintained at cracking and converting temperature, the necessary heat to bring it thereto being imparted during the passage of the oil through the tube; evolved vapors pass off from the upper portion of these containers, unoccupied by oil. In claim 2 it is stated that the device embodies "means for maintaining the lower portion of the oil relatively separate and distinct from the main body of the oil" and means are also provided for "subjecting said separate portion of oil to a local cracking and converting temperature." If the apparatus present in the Tube Stills, High Pressure Stills, and Continuous Stills are construed to be equivalents of that present in the Adams device, as above set forth, [fol. 46] and also in the features set forth in general answer "A" and "C", the device of Section 2 is used in this defendant's Tube, High Pressure and Continuous Still operations.

Further answering with respect to Section 4; as noted, this claim embodies the same feature of maintenance of a separate and distinct lower portion of the oil and of subjecting this separate body to local cracking and converting temperatures, as does Section 2. In addition, claim 4 requires that means be provided "for continuously introducing oil into said body of oil at the point where the cracking temperature is applied." In the Adams apparatus, fresh oil is directly introduced into the separate and distinct shallow body of oil which is directly subjected to cracking temperature. The operations of this defendant with re-

spect to this feature are set forth in general answer "D" above, which is made a part of the answer hereto. If the features set forth in general answers "A," "C" and "D," as well as those referred to in connection with Section 2, are construed to be the equivalents of the corresponding features of the apparatus of this Adams patent, the device of this section is used in the defendant's Tube, High Pressure and Continuous Still operations.

Sections 6 and 7 have been answered "T" in connection with the Continuous Stills. Further answering these sections, defendant refers to the descriptions of the elements of the device of the Adams patent and of those present in the Continuous type of stills operated by this defendant given in connection with the answers to Sections 2 and 4 above. In Section 6, the device of the Adams patent is described as containing "means for confining a body of oil," "means for subjecting a portion of said oil below the surface to a local cracking and converting temperature" and "means for continuously introducing oil into said body of oil at the point where cracking temperature is applied." In Section 7, the corresponding elements are described as "means for subjecting a limited portion of said oil at the lower part of said body (the whole body of oil) to a local cracking temperature" and "means for continuously supplying preheated oil to said limited portion of oil where cracking temperature is applied." If the devices present in the Continuous type of Still, as set forth in the answer to Sections 2 and 4 above and in general answers "A," "C" and "D," are construed to be the equivalents of the devices [fol. 47] present in the Adams structure, as above described, the devices of these sections are used in the Continuous Still.

Section 25 has been answered "T" with respect to the Continuous type of still. Further answering defendant refers to the descriptions of the Adams apparatus and of defendant's Continuous type of Still given in connection with Sections 2 and 4 above and in general answer "A" and "D." In the present section, the means in the Adams device for maintaining a separate and distinct body of oil is described as "an oil converter adapted to be raised to a cracking temperature" and the means containing the main body of oil with which said separate and distinct shallow

body of oil communications is described as "an expansion dome overlying said converter and in communication therewith." This claim also requires that means be present "for supplying oil to said converter." If the corresponding parts of the Continuous type of still are construed as equivalents of the parts of the Adams construction referred to in connection with Sections 2 and 4 above and in general answers "A" and "D," the device of this claim is used in the Continuous type of still.

XXXIX. The sections of this interrogatory correspond in number to the claims of the Adams patent 1,327,263. The original answer is hereby amended as to Sections 17 and 18 of the interrogatory by inserting the answer "T" (threatened) for the Tube Radiator, Tube Bubble Tower and High Pressure Still. Therefore, in the tabulation, change the claim number 15 under interrogatory XXXIX to "15, 17 and 18" and change claims numbered "16-23" to "16, 19-23."

Further answering with respect to Sections 1, 2, 4 and 5 of this interrogatory, this defendant says that each of these claims of this Adams patent requires that high boiling hydrocarbon oils in liquid form be subjected to a cracking temperature in a closed chamber, that the evolved vapors be passed through connections to a condenser in which they are condensed under pressure, and that there be open communication through the connections from the heated body of oil to and through the condenser. Defendant refers to its general answer "B" for description of the corresponding features of its types of stills. These sections also require uniform pressure from the container for heated oil to the condenser, in connection with which feature this defendant refers to its general answer "C," above.

Sections 1 and 5, further require the continuous supply of high-boiling oil to the chamber containing the heated [fol. 48] oil and Sections 2 and 4 require such a supply as will maintain an oil body therein. As to these features, this defendant refers to its general answer "D" above.

This defendant, further answering Sections 1, 2, 4 and 5 of this interrogatory, says that, if the features of its operations as set forth in its general answers "A," "B," "C" and "D" above are construed to be the equivalents of those in this Adams patent, as referred to in the two preceding

paragraphs, Sections 1, 2, 4 and 5 are used in each of the defendant's types of stills except the Shell Stills, in which they have been used and abandoned.

Further answering with respect to Sections 6 and 9, this defendant says that Section 6 requires that oil flow in a confined stream, which is heated to cracking temperature, and that Section 9 requires that oil flow in a thin stream through a pipe-like heater, in connection with which features defendant refers to its general answer "D" above. These sections require also the presence of the features referred to in the first paragraph of the answer to Sections 1, 2, 4 and 5 above, in connection with which general answers "B" and "C" are hereby made a part of the answer to Sections 6 and 9. If the features of this defendant's operations set forth in general answers "A," "B," "C" and "D" are construed to be the equivalents of the features of claims 6 and 9 of this patent, as set forth in this paragraph, the processes of Sections 6 and 9 of this interrogatory are used in this defendants Tube, High Pressure and Continuous operations.

Further answering Section 7, this defendant says that this section includes the features set forth in the answer above to Sections 1, 2, 4 and 5, except that it omits reference to feed or supply of oil, as noted in connection with those sections in the first paragraph of the answer thereto. This defendant further says that if the features of its operations as set forth in its general answers "A" and "C" are construed to be the equivalents of those in this Adams patent, as set forth in its claim 7, Section 7 is used in the Tube, High Pressure and Continuous Stills.

Further answering as to Sections 10, 11, 12 and 15 to 24, the defendant says that in its Continuous Stills, the oil is passed through a long series of pipes or tubes in which it is heated to at least a conversion temperature. From such pipes or tubes the oil is discharged into large vertical containers in which large bodies of the oil are maintained at conversion temperature by the application of inconsider- [fol. 49] able amounts of heat inadequate to further raise the temperature of the oil. In said vertical chambers the sides of the chambers are swept free of carbon deposits by a rotating scraper, and to a greater or less extent, the carbon settles by gravity to the lower portions of the cham-

bers. In the operation described in this Adams patent, the oil is heated to cracking temperature in a vertical pipe-like heater, in which is provided a rotating scraper which removes carbon deposits from the sides of the pipe. From this pipe-like heater the oil passes into an enlarged chamber.

In this defendant's Tube and High Pressure Still operation, a large bulk supply of oil is maintained in a bulk supply container, which, in the High Pressure Still, is formed of a plurality of interconnected containers. In each of these types of stills, the containers connect with headers or manifol-s, between which extend a plurality of pipes or tubes, which are in the heating zone of the furnace. The heat applied to these tubes produces circulation of oil from the bulk supply container through the tube and tank back to the bulk supply container, thereby maintaining the oil in the latter at cracking temperature. In passing through the tubes, at least some carbon or carbon-forming material formed in the tubes is swept out by the oil.

The features set forth above in connection with the Continuous, Tube, and High Pressure Stills, are hereinafter designated the "Carbon Removal Features."

If this defendant's operations are construed to be the equivalents of those of this Adams patent in the "Carbon Removal Features" set forth above and also in those set forth in general answers "A," "B," "C" and "D" above, then Sections 11, 19 and 20 are used in the Continuous Stills and Sections 10, 12, 15, 18 and 24 are used in the Tube, High Pressure and Continuous Stills.

If this defendant's operations are construed to be the equivalents of those of this Adams patent in the "Carbon Removal Features" above set forth and also in those set forth in general answers "A," "C" and "D," then Section 16 is used in the Continuous Stills, and Section 17 in the Tube, High Pressure and Continuous Stills.

If this defendant's operations are construed to be the equivalents of those of this Adams patent in the "Carbon Removal Features" set forth above and also in those set forth in general answers "A," "B" and "C" above, then Sections 21, 22 and 23 are used in the Continuous Stills.

[fol. 50] Further answering Sections 25 and 28 of this interrogatory this defendant says that if the features of

its operations as set forth in general answers "A," "B," "C" are construed to be the equivalents of those of this of this Adams patent, as expressed in these claims, these sections are used in each of its types of operations, except that the process of Section 25 has been abandoned in its Shell types of stills.

Further answering Sections 26, 27 and 29 of this interrogatory, this defendant says that if the features of its operations as set forth in general answers "A," "B" and "C" are construed to be the equivalent of those of this Adams patent, as expressed in these claims, these sections are used in each of its types of operations.

XLIV. The sections of this interrogatory correspond to the identically numbered claims of the Adams patent No. 1,433,519.

Section 2 has been answered "T" with respect to the Continuous type of installation. Further answering this interrogatory, this defendant says that in the operation shown in this Adams patent there are a plurality of chambers or converters, each of which is provided with heating means, operating independently, and in each of which oil is heated from below a cracking temperature to a cracking and conversion temperature. Each of these chambers is connected to a common vapor line or manifold leading to a single condenser. In the Continuous type of installation of this defendant, the oil to be treated is passed first through a long heated pipe coil, in which it is raised from below conversion temperature to a temperature at which cracking and conversion takes place. From this coil, the oil passes to interconnected chambers, to which only sufficient heat is supplied to maintain the oil at a conversion and cracking temperature. The vapor passes in series through successive ones of these chambers, being drawn off from the last. The process of this claim further requires that vapor pressure be maintained in the chambers through which the oil passes in series. In this defendant's installations, the pipe coil in which the oil is heated to conversion temperature communicates only with the enlarged chamber in which further conversion takes place, and has no vapor space. If the Continuous Still construction of this defendant is construed to be an equivalent of that set forth in this Adams patent in the features above set forth and in

those set forth in general answers "A," "C" and "D," the process of this section and of this claim of the Adams [fol. 51] patent is used in this defendant's Continuous Type of installation.

Further answering as to Section 3, this defendant says that the process of this section, corresponding to claim 3 of this Adams patent requires the presence of a series of separate converting chambers, in which oil is heated to cracking temperatures, and requires also that the vapor spaces in said converters be maintained in free and open communication with one another. In this defendant's Tube and Shell types of installation, a number of converting stills are arranged in a row. Oil is heated to cracking and conversion temperatures in each of the stills. Each of the stills is provided with an independent overhead or vapor system by which vapors are conducted to devices which prevent the passage of large proportions of the vapors, and the remaining vapors and gases pass to a final condenser, the condensate and cooled gas issuing from the latter into an independent receiving drum, in which separation of condensate from gas takes place. The gas from these independent receivers, or from a number thereof, is discharged into a common vapor line, which communicates with the vapor spaces in a number of the receiving drums from different stills in the row. If this operation of this defendant's Tube and Shell Stills is construed to be an equivalent of that described in this Adams patent, in the features set forth herein and in general answers "A," "C" and "D," this section is used and abandoned in the Shell Radiator and Shell Bubble Tower Stills and used in the Tube Radiator and Tube Bubble Tower Stills.

Section 4 has been answered "T" with respect to the High Pressure and Continuous types of stills. This defendant, further answering, says that the process of this section and of the corresponding claim of this Adams patent requires the presence of a series of separate converting chambers, and the heating of the oil in said chambers to cracking temperatures. The pertinent features of construction and operation disclosed in this Adams patent have been set forth in connection with preceding sections of this interrogatory and to such extent the answers to such sections are hereby made a part of this defendant's further reply to this section thereof.

Further answering with respect to the High Pressure type of installation, his defendant says that in this type of ins-allation, there is provided a plurality of interconnected drums, which together form a container for a bulk supply of oil. These interconnected containers are protected from [fol. 52] direct heating. Certain of them communicate with headers or manifolds, which are connected by tubes passing through the furnace setting and to which direct heat is applied. Certain of the chambers forming the container for the bulk supply of oil have vapor spaces, and these communicate with one another and with a vapor line. If this construction is construed to be an equivalent of that disclosed in this Adams patent in the features set forth herein and in those set forth in general answers "A," "C" and "D," the process is used in Defendant's High Pressure Stills.

Further answering Section 4 with respect to the Continuous type of installation, this defendant says that in this type of installation, oil is forced to pass through a heated pipe coil in which heat in applied to bring the oil from below conversion temperature to a conversion and cracking temperature. From this heated pipe coil the oil passes into a plurality of enlarged chambers which are interconnected so that there is free communication of vapors and liquids therebetween. The vapor spaces of these enlarged chambers are connected by a vapor line to a reflux condenser, and uncondensed vapors and gases pass therefrom to a final condenser. The intercommunicating large chambers are heated only sufficiently to maintain the oil therein at conversion temperatures. If this construction is construed to be an equivalent of that disclosed in this Adams patent in the features set forth herein and in those set forth in general answers "A," "C" and "D", the process is used in the Continuous type of installation.

Section 5, which corresponds to claim 5 of this patent, has been answered "T" with respect to the Continuous installations. Further answering, this defendant says that in its further answers to preceding sections of this interrogatory, the construction of this Adams patent and the construction of this defendant's Continuous type of Still has been set forth, and such answers are, to such extent, made a part of the answer hereto. If the operation conducted in its Continuous Stills is regarded as an equiva-

lent of that disclosed in this Adams patent as to the features referred to in such answers to preceding section, and in general answers "A," "C" and "D", the process of this section and of the corresponding claim of this Adams patent is used in its Continuous type of installation.

Section 6 has been answered "T" as to each and all of this defendant's types of installations. Further answering, this defendant says that in its answers above to pre- [fol. 53] ceding sections of this interrogatory, this defendant has set forth the various features of construction and operation of each of its several types of installations wherein a plurality of chambers are involved, in which oil is heated or converted, and also its several constructions whereby communication is effected between groups of converting systems or parts thereof in each of its several types of installations. To that extent, this defendant's answers to previous sections of this interrogatory are made a part of its further answer to this section thereof. If this defendants constructions and operations are construed to be the equivalents of those stated in such previous sections of this interrogatory and in general answers "A" and "C", the process of this section is used in each of its various types of installations.

The processes of Sections 7, 8, 9 and 11 of this interrogatory have been answered "T" or "Ta" with respect to each type of this defendant's installations except the Continuous type in which they are used. Further answering these sections, which correspond to the identically numbered claims of Adams patent 1,433,519, this defendant says that in each of defendant's types of installations except the High Pressure and Continuous types, a plurality of converters, each of which contains oil at cracking temperature, is arranged in a row, each being provided with a vapor system by which vapors are separately conducted from each converter or still to a reflex condenser, and the remaining vapors and gases are conducted to a final condenser from which condensate and cool gas goes to a receiver in which separation of vapor and gas is effected; and that the only communication between the vapor spaces of the system is the communication from the receivers for condensate to a common gas line or manifold. Further answering, this defendant says that, as previously stated in connection with

preceding sections of this interrogatory, in the High Pressure type of installation there is provided a plurality of drums which together form a bulk supply chamber from which oil is passed through tubes in a furnace setting and back to said drums; that some of these drums have vapor spaces which communicate with a common line leading to a reflex condenser and thence to a final condenser. If these constructions and also the features set forth in general answers "A", "C" and "D", in connection with Sections 8 and 9, and general answers "A" and "C" in connection with Sections 7 and 11, are construed as the equivalent of those disclosed in this Adams patent, the processes of these [fol. 54] Sections are used in the Tube and Shell Stills except that the use of Sections 8 and 9 in the Shell Stills has been abandoned.

Sections 18 and 19 of this interrogatory have been answered "T" with respect to the Continuous type of installation. Further answering with respect to these Sections, this defendant says that each of these Sections, corresponding to claims 18 and 19 of the Adams patent 1,433,519, requires, among other features, the passage of oil continuously through series of connected and highly heated converters in which the oil is concurrently cracked, the removal of unconverted oil, and the return of such unconverted oil to the first converter of the series. This defendant's Continuous type still has but just been placed in operation, and it has not yet been determined whether, in the operation of such units, there will be conducted such a return of unconverted oil to any part of the system or to any still or converter forming a part thereof. This defendant shall not adopt such an operation as part of its practice until it has extensively experimented therewith and determined its value. Further answering, this defendant says that in further answering previous sections of this interrogatory it has pointed out and compared the construction of its Continuous Stills with the construction set forth and disclosed in this Adams patent, and that, even if the return of unconverted oil to a part of the system be made a step in the process adopted by this defendant, the construction must be construed to be an equivalent of that of this Adams patent in the features set forth in such previ-

ous sections as well as those set forth in general answers "A", "C" and "D" if Sections 18 and 19 of this interrogatory are used.

Section 28 of this interrogatory has been answered "T" with respect to the Continuous type of operation. Further answering with respect to this section, this defendant says that the structure and operation described in the Adams patent from which this claim is drawn has been set forth in answers to preceding Sections of this interrogatory. In the operation conducted in this defendant's Continuous Stills, oil is first fed through a heated pipe coil, from which it is discharged into the first one or the first two of four enlarged chambers, connected in series both above and below the level at which liquid is kept therein. Oil is withdrawn from the last one or from the last two of these chambers, whereby a flow through the device results. Vapors are withdrawn from the chambers, which are maintained at cracking temperatures, and pass into devices whereby the passage of [fol. 55] a very large proportion of vapors formed will be checked, and the remaining vapors and gases, passage of which is not prevented, will be condensed and cooled respectively, likewise under pressure. If this operation and those set forth in general answers "A", "C" and "D", are construed to be the equivalents of those set forth in the Adams patent 1,433,519, from which this claim is drawn, the process of the section is used in the Continuous type installation.

XLVIII. The Sections of this interrogatory correspond in number to the respective claims of the Adams patent, 1,461,017. Further answering with respect to this interrogatory, this defendant says that in the structure disclosed and described in this patent, a tube or a plurality of tubes extend through a heating zone, projecting both above and below this heating zone. Above the heating zone, the tube or tubes each connect with an enlarged chamber or dome, and below the heating zone, they each connect with a chamber intended for the reception of deposited carbon. A rotating scraper is provided within each tube, extending through that portion of the tube within the heating zone, and removes deposits of carbon from the walls thereof. Oil is fed to the tube or tubes below the heating zone, flowing

upwardly therethrough. In the portion of the tubes within the heating zone, the oil is heated to conversion temperatures.

In the Continuous type of apparatus of this defendant, oil passes through an elongated pipe of restricted cross-section, in which it is heated to cracking temperature, and enters a plurality of chambers from which gases and vapors are drawn off to be subsequently in whole or in part condensed. Any carbon formed in the elongated passage or tube is, to a greater or less extent, swept out of said passage by the velocity of the oil passing therethrough. The chambers are mildly heated through their central portions to maintain cracking temperatures, and are there provided with rotating internal scrapers by which carbon deposits are removed from their walls. The heat externally applied to these chambers is only sufficient to prevent substantial drop in temperature, and is not of itself adequate to bring them to cracking temperature. Further answering with respect to this section, this defendant says that, if the construction is construed to be an equivalent of that described and claimed in this Adams patent, in the features above set forth and in those set forth in general answers "A," "C" and "D" the process of Section 4, of this interrogatory is used in the Continuous type installation.

[fol. 56] Further answering Section 5, if the construction of this defendant's Continuous Still is construed to be an equivalent of the structure disclosed and described in this Adams patent, in the features above set forth and in those set forth in general answer "A", the device of this section is used in this type of apparatus.

Further answering Section 7, this defendant says that if the construction of its Continuous Stills is construed to be the equivalent of that of this Adams patent in the features above set forth and in those set forth in general answers "A" and "C", the device of this section is used.

Further answering Sections 8 and 9, this defendant says that if the construction of its Continuous Stills is construed to be the equivalent of that of the Adams patent in the features set forth above and in those set forth in general answers "A", "C" and "D", the device of these sections is used therein.

Further answering as to Sections 16, 20 and 22, this defendant says that if the features of its Continuous Stills are construed to be the equivalents of those of this Adams patent in the features above set forth and in those of general answers "A" and "D", the devices of these sections are used therein.

Further answering as to Section 21, this defendant says that if the features of its Continuous Stills are construed to be the equivalents of those of the Adams patent in the features above set forth and in those of general answers "A", "B", "C" and "D", the device of this section is used therein.

L. Section 32 of this interrogatory corresponds to claim 32 of the Adams patent 1,462,677. Further answering Section 32 of this interrogatory, defendant says that this Adams patent shows a plurality of vertical tubes enveloped intermediate their ends by a furnace in which heat is applied thereto. The oil is fed into and through the vertical tubes and is heated therein to cracking and converting temperature.

Further answering, this defendant says that in its Continuous type of Still, it provides vertical chambers which are enveloped intermediate their ends by a heating chamber. The oil that is supplied to these vertical chambers has already been brought to converting temperature, and only sufficient heat is supplied during its passage through the vertical chambers to prevent its temperature dropping to below conversion temperature. If this construction is construed to be an equivalent of the construction described [fol. 57] and disclosed in this Adams patent, in these features and in those set forth in general answers "A", and "D", the process of this section of interrogatory L is used in the Continuous type installation.

LI. Section 23 of this interrogatory corresponds to claim 23 of Adams patent 1,462,678. Further answering this section of interrogatory LI, this defendant says that the structure described and disclosed in this Adams patent is the same as that described and disclosed in patent No. 1,462,677, the claims of which form the sections of interrogatory L, to which reference is made above. If the operations conducted in this defendant's Continuous Stills are construed to be the equivalent of those of the Adams pat-

ents in the features above set forth in connection with interrogatory L and in those set forth in general answers "A" and "D", the process of this section is used therein.

LVI. The sections of this interrogatory correspond to the identically numbered claims of the Hall patent No. 1,242,795.

Further answering with respect to Sections 3, 8 and 9, defendant says that in the device described and disclosed in this patent, oil is heated to conversion temperature and the resulting products are caused to pass through a cooler or condenser, in which they are partially cooled to a temperature of about 200° C. (392° F.), and the condensate and cooled liquids resulting are separated from the uncondensd vapors and gases, which are subjected to pressure and further cooled to effect additional condensation. Claims 3, 8 and 9 of this patent, which are Sections 3, 8 and 9 of this interrogatory, describe a process in which a hydrocarbon oil is cracked under pressure, the vapors and gases produced are cooled sufficiently to cause the portions thereof having boiling points of about 200° C. to condense and the remaining uncondensed gases and vapors are subjected to a pressure of not less than 70 pounds per square inch (as stated in claim 3) or to a pressure of several atmospheres (as stated in claim 8) or to a pressure materially above atmospheric, (as stated in claim 9). In all of this defendant's operations, oil is subjected to converting temperatures under pressure. The vapors and gases evolved are cooled by reflux condensers to temperatures such that products having boiling points of about 500° F. under normal atmospheric conditions remain uncondensed. The uncondensed vapors and gases are then conducted, while still under a total pressure of vapors and gases of at least 75 pounds to a final cooler or condenser, in which a [fol. 58] final cooling step takes place. If this operation is construed to be an equivalent of that described and disclosed in this Hall patent, the processes of Sections 3, 8 and 9 of this interrogatory are used in each of the defendant's types of stills.

Further answering interrogatory No. LXX, this defendant is advised that Sections 1 to 15 correspond to the identically numbered claims of Ellis patent 1,318,060, granted October 7, 1919. Further answering Sections 1 to

15 of this interrogatory, this defendant says that in the process described in this Ellis patent, the initial material employed is a much lighter oil than is employed in this defendant's operations excepting those conducted in its High Pressure Stills. The process described in this patent is apparently conducted without the use of pressures above atmospheric, and under conditions such that the material under treatment is substantially in vapor form. In all of the operations of this defendant pressures greatly in excess of atmospheric are employed, and the material treated is substantially entirely in liquid form. In the operation of the process described in the patent, temperatures are employed which are substantially higher than any employed by this defendant in its operations except those conducted in its Continuous Stills, in which temperatures are employed approaching and, in future operations, probably overlapping the lower end of the range of temperatures emplcyed in the process of the patent. In the further treatment of the product described in the Ellis patent, it is redistilled, and the redistilled material is treated with dilute sulfuric acid initially, after which treatment with strong sulfuric acid may be employed. This defendant's treatment of its cracked products is fully disclosed in its original answer to interrogatories LXXI, LXXII and LXXIII.

This defendant's product is an extremely complex mixture of various hydrocarbons of various chemical properties. The chemistry of the hydrocarbon oils is extremely abstruse and this defendant does not know what are the several ingredients of its product, their proportions, or their individual characteristics. Furthermore, to determine with even approximate accuracy the constitution of defendant's product would involve an enormously complex chemical research which would certainly occupy several years.

The Ellis product is necessarily of a generally similar character, probably involving a similarly like number of [fol. 59] ingredients, and the determination with reasonable exactness of its composition would involve a like research.

This defendant does not know and knows no way of finding out within several years how its product compares in detail with the Ellis product, and is therefore wholly unable to call attention either to similarities or to differ-

ences, excepting to say that, in general, this defendant's product does have the characteristics pointed out in the several claims of the Ellis patent which were answered as threatening, but whether this defendant's product differs so markedly that it would be held to be a non-equivalent product, this defendant does not know and cannot find out in any reasonable time.

In view of the foregoing facts, the most specific answer which this defendant can make to subdivisions 1 to 15 of Interrogatory LXX is as follows:

This defendant does make and sell a product such as is defined in the language of subdivisions 1 to 15 of Interrogatory LXX, with the exception of the introductory clause of each subdivision which reads 'The herein described motor spirit'. This language refers to matter outside the interrogatories and the particular subdivisions being quoted from the Ellis patent No. 1,318,060, this language referring to the specification of said patent. This defendant is unable to say whether or not its product corresponds sufficiently with the product of the Ellis patent to be in fact and in law 'The herein described motor spirit', and is unable to give any further or better answer.

Defendant began the manufacture of a product answering to the language of these subdivisions (exclusive of the introductory clause) about 1914, and this defendant is now advised it did not manufacture any product answering to such language of the subdivisions, exclusive of the introductory clause of each, prior to about 1914.

Standard Oil Company (Indiana).

ANSWER OF DEFENDANT THE TEXAS COMPANY TO PLAINTIFF'S INTERROGATORIES

In general answer to plaintiff's interrogatories this de-
[fol. 60] fendant is advised that its commercial cracking process operations and apparatus, exclusive of operations of an experimental nature, may be divided into three main parts, or groups, as follows:

(a) The Hall process operations, which were conducted at Bayonne, New Jersey, in which the oil was cracked in

the vapor phase. These operations were carried out in four converter units, which were operated more or less continuously, as to one or more of the units, from January 1917 for a period of somewhat over two years and a half. During this period, the operations were confined to the production of gasoline-like material, except for a period of about ten months in 1918 when the units were utilized for the production of tolulol from coal tar solvent naphtha for the Ordinance Department of the United States Government.

The amount of stock charged to the process, except during the tolulol production, was approximately 68,600 bbls.

(b) The early Holmes-Manley Process operations, which were conducted at Port Arthur, Texas, on the first twenty-four batteries installed by this defendant. In the original installation of these batteries, the apparatus included a heating coil connected to four series-connected stills or retorts. The oil was charged continuously through the heating coil and into the stills, from which the evolved cracked vapors were passed to air condensers or separators, in which the heavier fractions were separated from the lighter fractions and returned or backtrapped as a condensate to the bottoms of the stills for further treatment. The lighter and uncondensed vapors passed on to the final condenser, and were ultimately collected as a distillate. These earlier operations are characterized and distinguished from the later operations mainly by the feature of returning or back-trapping the heavy condensate to the bottom of the stills.

(c) The later Holmes-Manley process operations, which were conducted at Tulsa, Oklahoma; Lockport, Illinois; and Casper, Wyoming; from the initial installations of the batteries in these respective places, and also at Port Arthur, Texas, after some or all of the twenty four batteries there had been modified and rearranged for the later and improved type of operation. The characteristic features of the later installations in question constituted, in general, the use of fractionating bubble-towers, in lieu of air condensers or separators, and the employment of [fol. 61] pumps for forcibly returning or back-trapping the hot condensate from the bubble towers to the entrance of the heating coils.

The entire operations of the Holmes-Manley cracking process, including both types (b) and (c) described above, are set forth in detail, in point of time and quantities of production of gasoline-like material in defendant's "Answers of The Texas Company to Suggested Questionnaire", submitted to plaintiff in this action under date of February 27, 1925.

This defendant is advised by counsel that interrogatories I to LXVIII, inclusive, are predicated upon various United States patents, either owned by defendant or under which defendant is licensed, and that the subdivisions of each interrogatory are based upon claims of said patents. For convenience and simplification in answering these interrogatories the attached "Schedule A" and "Chart A" have been prepared.

"Schedule A" has been compiled and arranged to identify the several interrogatories I to LXVIII and their subdivisions with the several patents and their respective claims, and in connection with "Schedule A" the main parts or groups of defendant's cracking operations, as outlined above under (a), (b), and (c), are identified for clarity of understanding as follows:

"Hall" indicating the operation described under (a).

"HM #1" indicating the operation described under (b).

"HM #2" indicating the operation described under (c).

In this "Schedule A" the use by this defendant of the apparatus or processes defined by the subdivisions of the interrogatories, and the claims of the several patents corresponding thereto, is approximately indicated under the three identifying headings "Hall", "HM #1" and "HM 2", and the approval or furnishing of plants and/or specifications to defendant's licensees is approximately indicated, under the heading "Approval".

Defendant is advised by counsel that the answers to interrogatories I to LXVIII and their respective subdivisions, corresponding to the claims of the several patents, involve matters of legal opinion as to the meaning and interpretation of patent claims, and its answers to these interrogatories are therefore made on advice of patent counsel.

Where it is possible to reach a reasonably definite conclusion that the process or apparatus is or has been used by defendant, such use is indicated on "Schedule A" by the letter "U". In certain cases where the use by defendant is, or has been, relatively limited or occasional, this [fol. 62] fact is indicated by suffixing the letter "U" with the Letter "L" and appears on "Schedule A" as "UL" while a brief explanation of the general extent of such limited use is given elsewhere in the Answer under the heading "Limited Uses". Where it is possible to reach a reasonably definite conclusion that the process or apparatus is not, or has not been, used by defendant, such lack of use is indicated by a dash "—". Between these two general groups of claims, however, defendant is advised by counsel that there are numerous claims, the applicability of which to defendant's processes or apparatus necessarily involve such an element of uncertainty as to justify a reasonable divergence of legal opinon, and, in a case of adversely held patents, to constitute a distinct threat or basis for dispute in a suit for infringement, the result of which could only be determined finally by a Court of last resort. As to this group of claims, which may be thus fairly considered debatable, or threatening, in the general sense just explained, the letter "D" is employed on "Schedule A".

"Chart A" has been prepared to show the extent and duration of use by this defendant of its two types or groups of Holmes-Manley process operations, hereinbefore outlined briefly. On this "Chart A" are plotted two curves appropriately identified with the Holmes-Manley operations by the legends "HM #1" and "HM #2". These curves are plotted with time as abscissae and the number of batteries in operation as ordinates. Thus, the two curves clearly show the number of batteries of the two types of Holmes-Manley installations in operation in defendant's plants at all times, while at the same time showing the duration of operations of the respective types of batteries.

Interrogatories I to LXVIII

This defendant is advised by counsel that the answers to Interrogatories I to LXVIII, inclusive, both with respect

to the duration of time of operations and the extent thereof, are truly stated or indicated on "Schedule A" and "Chart A" attached hereto, when read in conjunction the one with the other, while "Schedule A" also truly indicates or states whether or not this defendant has embodied the apparatus or processes of the several subdivisions of these interrogatories, and the patent claims corresponding thereto, in plans and/or specifications approved by it or furnished by it to its licensees, or any of them.

Schedule A

[fol. 63]

Interrogatory	Patentee	Patent No.	Claims	HM No. 1	HM No. 2	Hall	Approval
	Indiana Co. Patents:						
1	Lang	964575	1-7	....	....	....	....
2	Burton	1049067	1-2	D	D	....	?
3	Burton	1055707	1-2	....	....	....	....
4	Burton	1105961	1-2	D	D	....	?
5	Burton	1112113	1-2	....	....	....	....
6	Clarke	1119496	1	....	UL	....	Yes
			2-3	....	D	....	?
7	Humphreys	1119700	1-2	U	U	....	Yes
8	Humphreys	1122002	1-5	....	....	....	....
9	Humphreys	1122003	1-4	....	....	....	....
10	Rogers & Cooke	1122220	1-19	....	....	....	....
11	Clarke	1129034	1-6	....	....	....	....
12	Moore	1130318	1	....	....	....	....
13	Clarke	1132163	1-4	....	....	....	....
14	Burton	1160689	1-3	UL	U	....	Yes
15	Cash	1230065	1-3	....	....	....	....
16	Humphreys & Burton	1343674	1-3	....	....	....	....
17	Lewis & Cooke	1392584	1-7	....	U	....	Yes
18	Burton & Clarke	1448254	1-4	....	UL	....	Yes
			5, 6	....	U	....	Yes
19	Clarke	1388514	1-4	....	....	....	....
20	Palmer	1187380	1-3	....	....	....	....
21	Palmer	1313009	1-3	....	....	....	....
22	Palmer	1360973	1-4	....	....	....	....
	New Jersey Co. Patents:						
23	Wells	1187874	1-6	....	....	....	....
24	Wells	1232454	1-10	....	....	....	....
25	Wells	1248225	1-3	....	....	....	....
26	Ellis	1216971	1-6	....	....	....	....
27	Ellis	1249278	1-9	....	....	....	....

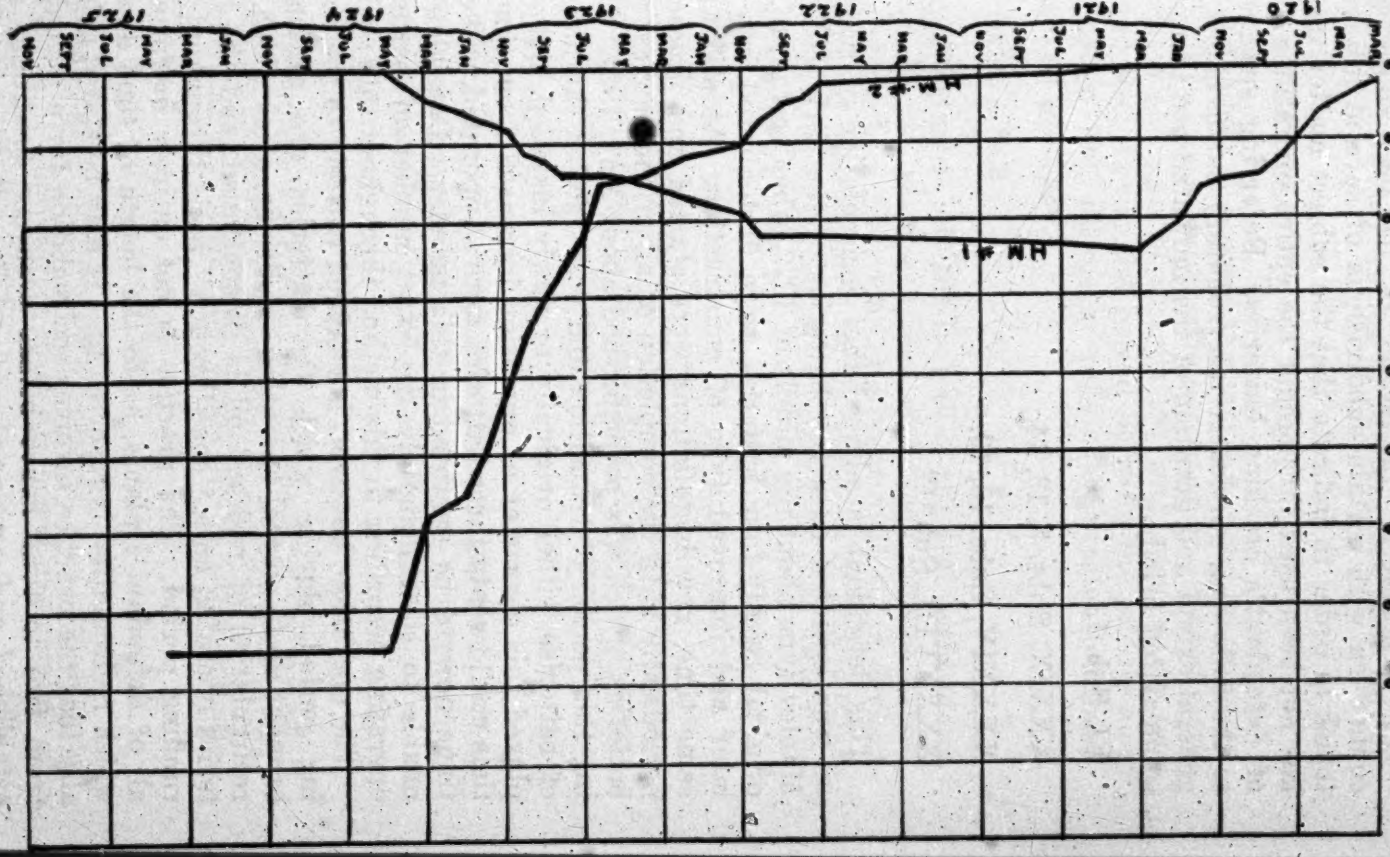
28	Ellis	1317868	1-23	....	....	....	....
29	Ellis	1341975	1-11	....	....	....	....
30	Ellis	1396999	1-12	....	....	....	....
[Vol. 64]							
31	Ellis	1415232	1	U	U	....	Yes
			2, 3, 5, 7, 9, 10	....	....	....	....
			4, 6, 8	D	D	....	?
32	Clarke	1405286	1-8	....	....	....	....
33	Clarke	1410797	1	....	DL	....	....
			2-4	....	....	....	....
34	Clarke	1413899	1-6	....	....	....	....
35	Clarke et al	1478102	1-7	....	....	....	....
	Texas Company Patents:						
36	Adams	1320854	(1-8) (10-12) 21, 22 (25-28)	....	....	....	....
			9, 17, 23, 24	D	D	....	?
			(13-16) (18-20)	U	U	....	Yes
37	Adams	1320726	(1-11)	....	....	....	....
38	Adams	1320727	(1-28)	....	....	....	....
39	Adams	1327263	(1-2) (4-12) 15, 16 (19-31)	U	U	....	Yes
			3, 13, 14	....	UL	....	Yes
			17, 18	....	....	....	....
40	Adams	1428311	1-9	....	....	....	....
41	Adams	1428312	1-7	....	....	....	....
42	Manley	1428338	1-8	....	....	....	....
			9	....	D	....	?
43	Manley	1428339	(1-11)	....	....	....	....
44	Adams	1433519	(1-17) (21-23), 25, 27, 28	U	U	....	Yes
			18, 19	....	UL	....	Yes
			20, 24, 26	....	....	....	....
45	Adams	1445281	1-9	....	....	....	....
46	Adams	1455376	1-9	....	....	....	....
47	Adams	1455377	1-14	....	....	....	....
48	Adams	1461017	(1-3) 5, (7-9) (13-15) 17, 19, 21	U	U	....	Yes
			4, 6	....	....	....	....

Schedule A—Continued

Interrogatory [fol. 65]	Patentee	Patent No.	Claims	HM No. 1	HM No. 2	Hall	Approval
			10, 11, 16, 18, 20, 22	D	D	....	?
			12	....	UL	....	Yes
49	Manley	1462143	1-6	....	....	....	....
			7, 8	....	D	....	?
50	Adams	1462677	1-32	....	....	....	....
51	Adams	1462678	1-23	....	....	....	....
52	Adams	1477860	1-5	....	....	....	....
53	Hall	1175909	(1-8) (10-12) (14-17)	....	....	....	....
			9, 13, 18	....	....	U	....
54	Hall	1175910	9, (11-15) 17	....	....	D	....
			1-8, 10, 16	....	....	....	....
55	Hall	1194289	(1-11)	....	....	....	....
56	Hall	1242795	(1-9)	....	....	....	....
57	Hall	1242796	1, (3-18) (20-24)	....	....	....	....
			2, 19	....	....	U	....
58	Hall	1285136	1-7	....	....	U	....
59	Hall	1261930	1-2	....	....	....	....
60	De Florez	1437045	1, 3, 5, 6	....	....	U	....
			2, 4	....	....	....	....
61	Adams	1506877	(1-3)	....	....	....	....
62	Adams	1506878	(1-13)	....	....	....	....
	Gasoline Products Co. Patents:						
63	Cross	1203312	(1-6)	....	....	....	....
64	Cross	1326851	1	....	....	....	....
65	Cross	1423500	1-15	....	....	....	....
66	Cross	1437229	1	....	....	....	....
	Miscellaneous Patents:						
67	Chamberlain	1221790	1-25	....	....	....	....
68	Clarke	1413260	1-9	....	....	....	....

[fol. 66]

Chart A



[fol. 67] Limited Uses

On "Schedule A" the letter "L" has been employed in connection with certain subdivisions of several interrogatories in order to indicate that the subject matter thereof has not been used throughout the entire operations of all of defendant's cracking batteries. Referring specifically to the following particular interrogatory subdivisions, the general extent and duration of the indicated use thereof is summarized briefly.

VI, Sub. 1.

XXXIX, Subs. 3, 13, 14.

XXXXIV, Subs. 18, 19.

XXXXVIII, Sub. 12.

This defendant is advised that recirculation of residual oil was initiated on a few batteries of the early Holmes-Manley type about the middle of 1922, when certain of the original twenty-four batteries were first altered into the later and improved type of construction. At about the same time, new installations were started and proceeded periodically until the completion of all of the now existing batteries, which was accomplished about May, 1924. During this period of transition and construction the number of batteries, either originally or newly installed, that employed this character of operation increased from time to time until twenty-three batteries were so operated, and continue now to be operated in this manner. Defendant is unable to state definitely the exact number of batteries operating according to this method throughout this period.

The operation, however, is confined entirely to the starting period, during which the batteries are gradually brought up to normal operating conditions, after which the recirculation of residual oil is discontinued, and the batteries operated on a "once-through" basis throughout the running period. The practice is not entirely uniform in all of defendant's plants, as to the length of time during which recirculation is resorted to. It may be stated generally that the practice involves recirculation for a period of from two to four hours before cracking conditions are established and continued recirculation of from none to

about six hours after cracking conditions have been attained. The entire period of recirculation during start-
[fol. 68] ing, probably varies in extent from four to ten hours.

XIV, Subs. 1 to 3.

This defendant is advised that after the middle or latter part of 1922 all new Holmes-Manley batteries erected were equipped at the time of installation with such safety devices, and that during the period between the middle and latter part of 1922 all of the previously erected batteries were also so equipped.

XV, Subs. 1 to 3.

This defendant is advised that all of the first twenty-four batteries erected were provided with such stuffing boxes, but that by substantially the middle of 1921 these devices were removed and replaced by devices of a different type. None of the batteries constructed after that time were provided with such devices.

XVIII, Subs. 1 to 4.

Defendant is advised that only two of its batteries are commercially operated in this manner, and that these operations were commenced about the first of March, 1925.

XXXIII, Sub. 1.

Defendant is advised that, if this process be employed, commercial operations have been confined to four batteries, since approximately the middle of October, 1924.

LXIX

This defendant is advised that the gasoline-like material produced by its cracking operations is substantially different from that produced from crude oil by fractional distillation.

LXX

This defendant is advised by counsel that the several subdivisions of this interrogatory are based upon claims of the patents indicated below:

Subdivisions		Patent		Claims
(a)	1-15	Ellis	1,318,060	1-15
(b)	16-45	Hall	1,239,099	1-30
(c)	46-64	Hall	1,239,100	1-19
(d)	65-66	Ellis	1,396,999	13-14
(e)	67-68	Clarke	1,413,260	22-23

[fol. 69] (a) This defendant is advised that all of its cracked product produced by both types of its Holmes-Manley cracking process and all of the cracked product of the Hall cracking process, (except for that produced during the period it was operated for the Ordnance Department to make tolulol) is substantially like that defined in sub-divisions 1-15, and the correspondingly numbered claims of the Ellis patent 1,318,060.

(b) (c) This defendant is advised that all of the cracked product of the Hall process (except for the operations of the Ordnance Department) was substantially like that defined in subdivisions 16, 19, 21, 23 and 24 of this interrogatory and that claims 1, 4, 6, 8 and 9 of the Hall patent, 1,239,099, corresponding thereto, cover the product so produced. As to the remaining subdivisions under (b) and (c), defendant is advised that its product of the Hall process may or may not have been like that defined. Defendant does not know. However, its Hall cracking plant was built and operated in substantial accordance with the Hall patents, and under the supervision and direction of the Chief Engineer of the Motor Petrol Company, then owner of the Hall patents, and defendant presumes but cannot affirm that the product produced corresponded to that defined in some, if not all, of the remaining sub-divisions under (b) and (c).

As to all subdivisions of this interrogatory, not otherwise mentioned above, defendant is advised that none of its cracked products, produced either by its Holmes-Manley or Hall processes, conform to the patent claims corresponding thereto.

LXXI

Defendant is advised that approximately 32% of the total amount of cracked gasoline-like material produced by its Holmes-Manley cracking process from the beginning of its operations has been treated with dilute sulphuric acid.

However, of all the cracked gasoline-like material produced by defendant in the year 1924, approximately 44% was treated with dilute sulphuric acid, while the figures available for the first three months of 1925 indicate that approximately 50% of the current production is being so treated.

LXXII

Defendant is advised that approximately 47% of its total amount of cracked gasoline-like material produced by its [fol. 70] Holmes-Manley process from the beginning of its operation has been treated with concentrated or undiluted sulphuric acid of approximately 66° Be. gravity.

During the year 1924, however, approximately 25% of its yearly production of cracked products was treated with concentrated or undiluted sulphuric acid.

Of defendant's production for the first three months of the year 1925, less than 20% has been so treated.

LXXIII

Defendant is advised that the concentration and gravity of the acids normally used in the treatment of its cracked gasoline-like material produced by its Holmes-Manley process is as follows:

	Concentration	Gravity
Weak	62%	50° Be.
Strong	93%	66° Be.

LXXIV

Defendant is advised by counsel that this interrogatory is based upon claim 2 of Ellis patent 1,318,061 and that defendant does employ the process defined therein in the operation of its Holmes-Manley process to produce gasoline-like material adapted for use as a motor fuel.

LXXV

Defendant is advised that gasoline-like material produced by its Holmes-Manley cracking process has not been treated with acids of different strengths than those mentioned above or with other equivalent purifying agents, except to a lim-

ited extent (now abandoned) in which approximately 2.3% of its total production of gasoline-like material has been treated with sulphuric acid of 60° Be. gravity—77.5% strength.

LXXVI

Defendant is advised by counsel that this interrogatory is based upon claim 1 of Burton patent 1,167,884 and that defendant does produce an oil defined thereby in the operations of its Holmes-Manley process.

[fol. 71]

LXXVII

Defendant is advised by counsel that this interrogatory is based upon claim 2 of Burton 1,167,884 and that defendant is unable to say definitely whether it employs the process defined, and considers this claim "threatening" to the process employed by it.

LXXVIII

Defendant is advised by counsel that this interrogatory is based upon claim 3 of Burton patent 1,167,884 and that defendant does produce the product defined thereby in the operations of ~~its~~ Holmes-Manley process.

LXXIX

(Answer required only by Indiana Company.)

LXXX

This defendant is advised that in all of its commercial Holmes-Manley process operations it has used many parts of the apparatus described and shown in the Adams patents listed in the interrogatory. Referring particularly to the Adams patents 1320354, 1327263 and 1433519, some of the important parts found in these patents and utilized by defendant in its Holmes-Manley process operations are as follows:

Supply tank.
Feed pump.
Preheating coil.
4 vertical cracking stills connected in series.

Air cooled preliminary condenser or separator. (Bubble towers have now replaced air condenser in the Holmes-Manley process equipment.)

Final water cooled condenser.

Gasoline collecting tank.

Furnace surrounding the still intermediate its ends.

A cool vapor chamber extending above the furnace and a cool carbon collecting chamber extending below furnace.

Rotary mechanical scraper mounted on central vertical shaft in the pressure still, and gearing for driving the shaft and scrapers.

[fol. 72] Interconnected vapor spaces of several stills constituting a battery.

Many of these parts appear in the other Adams patents, but the arrangement used by defendant more closely resembles the arrangement of the particular patents referred to.

Some of the process steps or features employed by defendant in its Holmes-Manley cracking operations and found in the same Adams patents 1320354, 1327263 and 1433519 are as follows:

Use of a distillate such as kerosene or gas oil as the starting material.

Variation or selection of the particular conditions of temperature and pressure according to the particular starting material utilized.

Preheating the oil before entering the cracking still.

Carrying on pressure distillation to produce vapors of the desired product.

Continuous feeding of starting material during the operation of the process.

Withdrawal of residue from the bottom of the stills during the operation of the process.

Preliminary cooling of the vapors as they leave the still to condense out the unconverted or insufficiently converted fractions and the return of such fractions for further treatment in the process.

Maintenance of open communication through the heating coil, stills, preliminary condenser and final condenser.

Maintenance of oil level in the stills above the heating zone to prevent burning at the surface and overheating the vapor.

Gravity precipitation of carbon formed in the process and scraped from the walls to the cool chamber at the bottom of the stills.

Heating stream of oil to high temperature in transit through a restricted tubular passage and then delivering heated oil into a large drum maintained at a cracking temperature largely by the heat of the incoming oil.

Many of the process steps and features above described appear in one or more of the other Adams patents listed in the question, but the Holmes-Manley process most closely resembles the particular patents referred to.

This defendant has used in all of its Hall process operations many of the parts of apparatus shown and described in the Hall patents listed in the interrogatory. With special reference to Hall patent 1,285,136, the parts of greater [fol. 73] importance found therein that were used by defendant are as follows:

Feed pump.

Preheating coil.

Vertically arranged cracking coil.

Three preliminary air cooled condensers.

Pressure-reducing device between cracking coil and condensers.

Condensate drawoffs from condensers.

Compression pump beyond air cooled condensers.

Final water cooled condenser under pressure.

Other Hall patents, 1,175,909, 1,175,910, 1,242,795 and 1,242,796 also shown most, if not all, of these parts. On the whole, perhaps the apparatus and process as employed by defendant in its Hall process operations, most nearly conforms to that disclosed in the De Florez patent 1,437,045 (not listed in this interrogatory).

Some of the process steps or features employed by the defendant in all of its Hall process operations and disclosed in certain of the above mentioned patents are as follows:

Use of a kerosene-like distillate as a charging stock.

Preheating the oil before introduction into the cracking unit.

Continuous feed of charging stock throughout the process.

Cracking operation carried on in the vapor phase in cracking coil at about 600° to 700° C and under from 70 to 100 lbs. pressure.

Release of pressure at the exit of the cracking coil and delivery into separators under about atmospheric pressure.

Condensing out and separation at atmospheric pressure of heavy and light condensates in the separators.

Recompression and subsequent cooling under pressure of the remaining material to produce the final product.

LXXXI

Defendant is advised that the Adams patents listed in Interrogatory LXXX disclose the following apparatus parts which have not, up to the present time, been utilized in the commercial operations of defendant.

Automatic float feed.

Electric heaters.

Single vertical tube opening into an expansion chamber above it.

Flat plate type of heater.

[fol. 74] Nest of overflow pipes inside the converter.

Spiral form of mechanical scraper.

Spray nozzles for superheated steam and oil vapor.

Boiler for vaporizing the oil before cracking.

Removable pans for collecting carbon in horizontal cracking chambers.

Heater for applying heat to the bottom of the cracking chamber.

Screens for breaking up the oil into spray in the cracking chamber.

Multiple tube cracking chamber, the tubes of which head into the vapor dome above into a carbon chamber below.

Cracking coil and expansion drum, all in one furnace.

Steam injector nozzles introducing steam into the cracking chamber.

Hot vapor pump for forcing oil vapors into vapor cracking coil.

Some of the process steps or features described in the Adams patents listed in Interrogatory LXXX and which have not been employed, up to the present time, by defendant in its commercial cracking operations are as follows:

Carrying air pressure on the supply tank as a means of forcing the oil into the system.

Cracking by uniting oil vapors and superheated steam.

Cracking by spraying oil vapors against a heated surface.

Vaporization of oil at atmospheric pressure and introduction of the oil vapors by pressure pumps into the cracking chamber for conversion in the vapor phase.

Heating of oil to incipient vaporization and the introduction of the oil in the form of vapors in the cracking chamber with or without steam.

Respecting the Hall patents listed in this interrogatory, the following apparatus parts shown therein which have not been employed by defendant in its Hall process operations are as follows:

Catalytic rods within cracking coil.

Screens within expansion chamber to catch carbon.

Air blower system on separators.

Preheating coil in furnace stack to absorb waste heat of combustion.

Divided cracking coil and furnace arrangement.

Packed or filled separators.

Cracking chamber filled with nickel balls or cubes.

Some of the process steps and features set forth in the [fol. 75] Hall patents listed, which have not been utilized by defendant in its Hall process operations are as follows:

Compressing the vapors and gases while in a hot state.

Transforming velocity energy of vapors into heat by impingement against obstructions.

Cracking of vapors in presence of catalysts.

LXXXII

This defendant has agreed to waive its minimums and to accept in lieu thereof one-half of the royalties actually collected by Gasoline Products Company from Atlantic Refining Company under its license agreement with the Atlantic Refining Company dated October 9, 1924.

This defendant has informally agreed with the Indiana Company to accept Fifty (50) dollars per unit per day, in lieu of five (5) cents per barrel, from the New Jersey Company for operations of Beacon Oil Company.

This defendant has informally agreed to waive its minimums and to accept in lieu thereof one-half of the total license money collected by Gasoline Products Company under its contract dated May 1, 1925 with the Vacuum Oil Company, licensing said company for one Cross unit on a lump sum basis, payable in advance.

This defendant has entered into an agreement under date on March 26, 1925, with the Richard Fleming Company and the Indiana Company.

This defendant has entered into an agreement under date of March 26, 1925 with the Marland Oil Company, one of the licensees of the Richard Fleming Company, and the Indiana Company.

LXXXIII

A copy of the agreement between this defendant, the Richard Fleming Company and the Indiana Company, and a copy of the agreement between this defendant, the Marland Oil Company and the Indiana Company are attached hereto.

The Texas Company

Memorandum of Agreement

This agreement, made and entered into this 26th day of March, 1925, by and between The Texas Company, a corporation of Texas, hereinafter called Texas, the Standard Oil Company, a corporation of Indiana, hereinafter called Indiana, and the Richard Fleming Company, a corporation of Delaware, hereinafter called Fleming;

Witnesseth:

Whereas, Fleming owns certain United States patents relating to heat and pressure cracking and has granted licenses thereunder for the operation of the so-called Fleming Cracking Process, and

Whereas, Texas and Indiana own United States patents relating to the same subject and which are infringed by the Fleming Cracking Process, as operated by the Fleming licensees, and

Whereas, Fleming desires to assist its licensees to secure a release and immunity under the heat and pressure cracking patents of Texas and Indiana,

Now, therefore, in consideration of the premises, and of the covenants and agreements hereinafter contained, the parties hereto do hereby covenant and agree as follows:

I. Fleming represents that it has issued prior to this agreement licenses to the companies listed in Fleming [fol. 76] License Schedule, Exhibit A, hereto annexed and

that the rights and conditions of payments and that the number and capacity of licensed units installed by such licensees are as set forth in said Exhibit A.

II. For the purpose of this agreement the term "Texas and Indiana Patent Rights" shall mean all patents of the United States or divisible interest therein, now or hereafter owned or controlled by Texas and/or Indiana, provided:

(a) that the patent or divisible interest therein is now owned or shall be acquired prior to January, 1937, or

(b) that the patent or divisible interest therein shall hereafter be acquired and shall be based on an invention made within ten years from the date hereof, and

(c) that the patent or divisible interest therein shall cover:

1. any pyrolitic cracking process.

2. any apparatus for carrying out any pyrolitic cracking process.

3. any products produced directly by any pyrolitic cracking process.

III. Texas and Indiana agree to give a release and immunity in writing in the form of Specimen Release, Exhibit B attached, under the Texas and Indiana Patent Rights, to any of the Fleming Cracking Process licensees specified in Exhibit A attached, permitting such licensee to continue to use the present licensed Fleming Cracking equipment (including repairs and replacements, but not enlargements thereof) upon the payment within one year from the date of this agreement, of an amount equal to $5000 per unit for each Fleming Cracking Unit now owned or operated by such licensee.

IV. For each of its licensees listed in Schedule Exhibit A attached, which shall receive a release and immunity from Texas and Indiana under Section III hereof, Fleming agrees to pay in addition to the payment called for under Section III hereof, 25% of all royalties collected by Fleming from such licensee after December 1, 1924.

V. Fleming agrees to set aside for the benefit of Texas and Indiana one-quarter of all royalties hereafter collected

[fol. 77]

Fleming License Schedule

(Exhibit A)

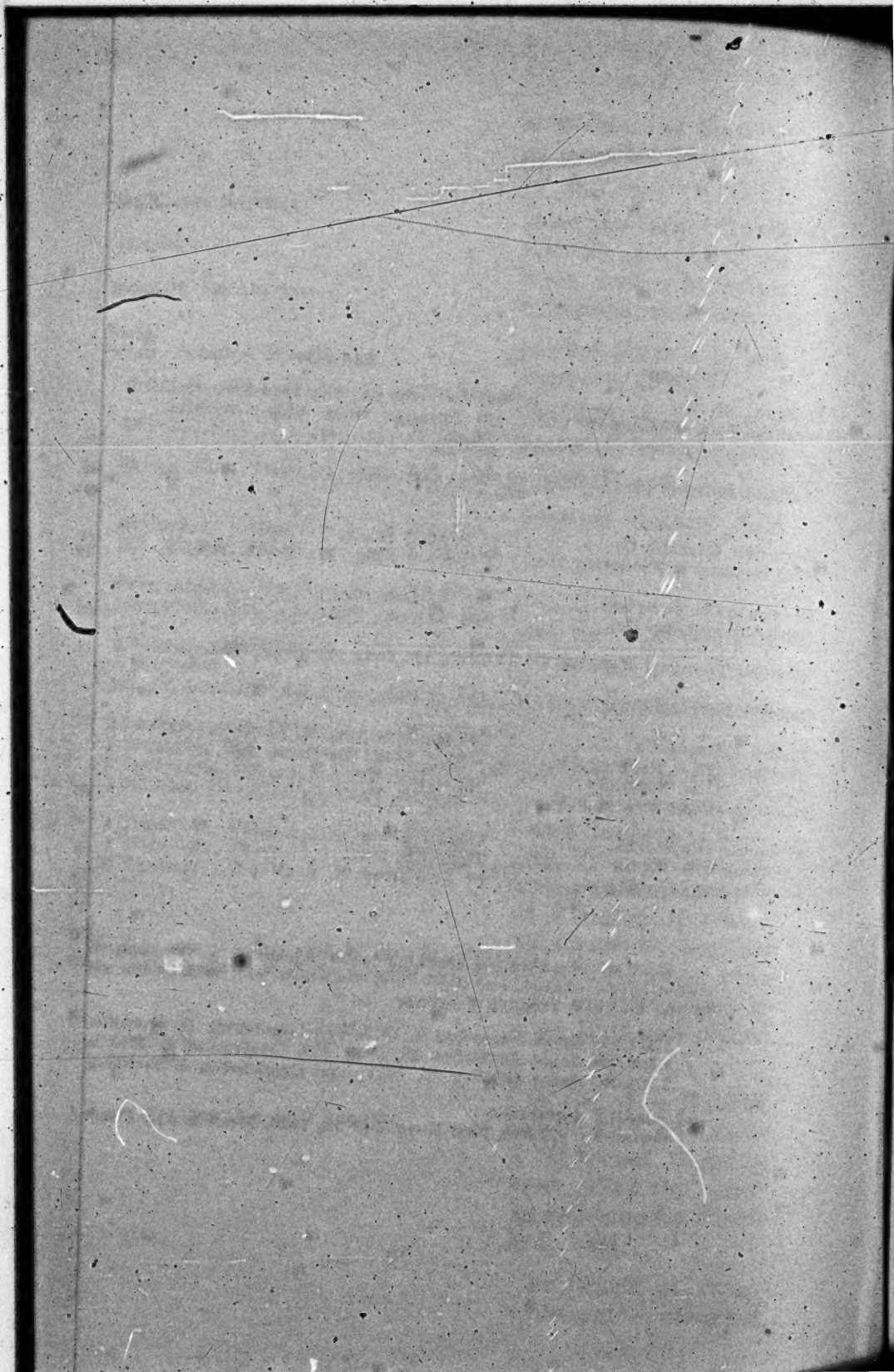
Fleming Cracking Installations

Company	Address	No. of units	Location of units	Royalty	Terms of payment
Shell Co. of Cal	343 Sansome St., San Francisco, Cal.	1	Martinez, Cal	1/2c. gal. gasoline	Monthly.
Sterling Oil & Refining Co	4th National Bank Bldg., Wichita, Kan.	6	Wichita, Kas	50,000 shares common stock Sterling Co.	Payment rec'd.
Mariand Refining Co	Ponca City, Okla	18	Ponca City, Okla	1/2c. gal gasoline or $306,000 or $495,000	1/2c. gal. monthly, or $306,000 in 2 yrs., or $495,000 in 5 yrs.
Barnsdall Refining Co	41 E. 42nd St., N. Y. City	8	Barnsdall, Okla	$146,500	Special.
Star Refining & Producing Co	Waggoner Bldg., Ft. Worth, Tex	1	Ft. Worth, Tex	$20,000	At rate of 1c. gal. gasoline total within 2 years.
Grayburg Oil Company	San Antonio, Tex	2	San Antonio, Tex	$20,000 per unit	Ditto.
Southern Refining Co	San Antonio, Tex	1	Somerset, Tex	1/2c. gal. gasoline or $20,000.	Monthly or capitalize within two years.
Houston Terminal Refining Co	Chronicle Bldg., Houston, Tex	1	Houston Ship Channel, Port Houston	1/2c. gal. gasoline or $20,000.	Monthly or in 2 yrs.
Lubrite Refining Co	Arcade Bldg., St. Louis, Mo	4	E. St. Louis, Ill	1/2c. gal. gasoline or $20,000 per unit	Monthly or in 2 yrs.
Indian Refining Co	244 Madison Ave., N. Y. City	5	Lawrenceville, Ill	$60,000 total	Special.
Portland Oil & Refining Co	Weller Bldg., Portland, Ind	1	Portland, Ind	1/2c. gal. gasoline	Monthly.
Louisa Co. of Kentucky	Louisville, Ky	2	Louisville, Ky	$20,000 per unit	4 semi-annual payments
Penn American Refining Co	Rouseville, Pa	4	Oil City, Pa	1/2c. gal. gasoline or $20,000 unit	Quarterly or in 2 yrs. In escrow 2 1/2 yrs.
Titusville Oil Works	Titusville, Pa	1	Titusville, Pa	$20,000	4 semi-annual payments
American Oil Works	Titusville, Pa	1	Titusville, Pa	$20,000	4 semi-annual payments
Vacuum Oil Company	61 Broadway, N. Y. C.	5	Paulsboro, N. J.	$20,000 per unit	Based on 6 mos. trial and upon acceptance, 1/2 cash, 1/2 in escrow.

Each of the Fleming cracking units scheduled above comprises a hammer-welded still 10 feet in diameter and 30 feet high, a dephlegmator cooled by the charge, and a jet type condenser, and each of the above listed licenses is licensed under the following Richard Fleming patents owned by the Richard Fleming Company:

1,324,766 dated December 9, 1919, Pro Conversion Hydrocarbons
1,325,668 dated December 23, 1919, Pro Condensing & Treating Distillates
1,304,987 dated October 25, 1921, App Condensing & Treating Distillates

and pending application:
Serial No. 425,044, filed November 19, 1920, Meth & App Condensing Oil Cracking Still Vapors.



from all of the licensees listed in Schedule A, and to pay currently to Texas the share of the same which accrues to Texas and Indiana under section IV hereof.

VI. Fleming agrees to render to Texas on March 1, 1925, and quarterly thereafter, a statement in writing, showing the royalty received by Fleming from each licensee listed on Exhibit A during the preceding quarter.

In witness whereof, the parties hereto have caused these presents to be executed on their behalf, and their corporate seals to be hereto affixed and duly attested by their respective officers thereunto duly authorized, the day and year first above written.

(Here follows Exhibit A—Fleming license schedule)

[fol. 78] EXHIBIT B

Specimen Release

For and in consideration of a certain agreement, dated —— —, ——, between The Texas Company, a corporation of Texas, hereinafter called Texas; the Standard Oil Company, a corporation of Indiana, hereinafter called Indiana; and The Richard Fleming Company, a corporation of Delaware, hereinafter called Fleming, and of the receipt of — Dollars ($5000 per unit) cash paid to Texas by —— ——, a corporation of ——, hereinafter called Licensee, for the benefit of Texas and Indiana;

1. Texas and Indiana hereby release the Licensee, under the Patent Rights of Texas and Indiana, from all claims for past infringement consisting in or resulting from the present Fleming Cracking Process Equipment of the Licensee, which it has constructed and operated under its certain license contract with Fleming dated —— —, ——, and Texas and Indiana hereby grant immunity to the Licensee under the Patent Rights of Texas and Indiana, for future operation of said present Fleming Cracking Process Equipment, including repairs and replacements thereof, but not enlargements, modifications or additions thereto.

2. For the purpose of this release the term "Patent Rights of Texas and Indiana" shall mean all patents of the United States or divisible interest therein, now or hereafter owned or controlled by Texas and/or Indiana, provided

(a) that the patent or divisible interest therein is now owned or shall be acquired prior to January, 1937, or

(b) that the patent or divisible interest therein shall hereafter be acquired and shall be based on an invention made within ten years from the date hereof, and

(c) that the patent or divisible interest therein shall cover:

1. any pyrolitic cracking process;

2. any apparatus for carrying out any pyrolitic cracking process;

3. any products produced directly by any pyrolitic cracking process.

3. Nothing in this release shall be construed to grant any license or immunity to the Licensee for any equipment other [fol. 79] than the aforesaid present Fleming Cracking Process Equipment, nor for the operation of any process except the process of oil conversion characterized by the following:

A body of oil maintained at a cracking temperature under pressure sufficient to give substantial increase in the boiling point while the evolved vapors are continuously removed from a point above the liquid level, the heavier constituents separated and condensed in a dephlegmator under pressure and the gasoline-like products released to substantially atmospheric pressure and condensed by a jet or syphon condenser. It shall not involve the feeding of the oil to the still at a cracking temperature and in no event shall the temperature of the oil fed to the still exceed 600° F. It shall not involve the condensation of a gasoline-like constituent under superatmospheric pressure. It shall not involve the use of scrapers or other mechanical means for cleaning the still or preventing the deposition of carbon thereon, during the operation of the process.

In witness whereof, the parties hereto have caused this instrument to be signed this — day of ——, 1925.

Release

This release made this 26th day of March, 1925, by and between The Texas Company, a corporation of Texas, hereinafter called Texas, the Standard Oil Company, a corporation of Indiana, hereinafter called Indiana, and Marland Refining Company, a corporation of Oklahoma, hereinafter called Marland;

Witnesseth:

For and in consideration of a certain agreement dated March 26, 1925, between Texas, Indiana, and The Richard Fleming Company, a corporation of Delaware, hereinafter called Fleming, and in consideration of the covenants here- [fol. 80] inafter recited, it is understood and agreed by and between the parties hereto as follows:

1. Texas and Indiana hereby agree to release Marland on payment to Texas of sums as hereinafter stated in Paragraph 2, under the Patent Rights of Texas and Indiana, from all claims for past infringement consisting in or re-

sulting from the present 18 unit Fleming Cracking plant of Marland which it has constructed and operated under its certain license contract with the M. W. Kellogg Company, a corporation of Delaware, dated July 18, 1922, and Texas and Indiana hereby agree, on receipt of said sums, to grant immunity to Marland under the Patent Right of Texas and Indiana, for future operation of said present 18 unit Fleming Cracking Plant, including repairs and replacements thereof, but not enlargements, modifications or additions thereto.

2. Marland agrees to pay to Texas for release and immunity as outlined in Paragraph 1 hereof, the sum of Ninety Thousand ($90,000) Dollars, of which Twenty-four Thousand ($24,000) Dollars is payable to Texas upon the execution of this agreement. The balance of Sixty-six Thousand ($66,000) Dollars to be paid in equal monthly installments of Three Thousand ($3,000) Dollars each, beginning April 1, 1925, all remittances to be made to W. W. Bruce, Treas., The Texas Company, 17 Battery Place, New York City.

3. For the purpose of this release the term "Patent Rights of Texas and Indiana" shall mean all patents of the United States or divisible interest therein, now or hereafter owned or controlled by Texas and/or Indiana, provided;

(a) That the patent or divisible interest therein is now owned or shall be acquired prior to January, 1937, or

(b) that the patent or divisible interest therein shall hereafter be acquired and shall be based on an invention made within ten years from the date hereof, and

(c) that the patent or divisible interest therein shall cover:

1. any pyrolitic cracking process

2. any apparatus for carrying out any pyrolitc cracking process

3. and products produced directly by any pyrolitic cracking process

4. Nothing in this release shall be construed to grant any license or immunity to Marland for any equipment other

than the aforesaid present 18 unit Fleming Cracking plant, [fol. 81] nor the operation of any process except the process of oil conversion characterized by the following:

A body of oil maintained at a cracking temperature under pressure sufficient to give substantial increase in the boiling point while the evolved vapors are continuously removed from a point above the liquid level, the heavier constituents separated and condensed in a dephlemgator under pressure and the gasoline-like products released to substantially atmospheric pressure and condensed by a jet or syphon condenser. It shall not involve the feeding of the oil to the still at a cracking temperature and in no event shall the temperature of the oil fed to the still exceed 600° F. It shall not involve the condensation of a gasoline-like constituent under superatmospheric pressure. It shall not involve the use of scrapers or other mechanical means for cleaning the still or preventing the deposition of carbon thereon, during the operation of the process.

In witness whereof the parties hereto have caused these presents to be executed on their behalf, and their corporate seals to be hereto affixed and duly attested by their respective officers thereunto duly authorized, the day and year first above written.

Supplemental Answer of Defendant The Texas Company to Plaintiff's Interrogatories

To the Honorable Judges of the District Court of the United States in and for the Eastern Division of the Northern District of Illinois:

Now comes this defendant The Texas Company, and in further answer to plaintiff's interrogatories dated April 1, 1925, submits the following:

Interrogatory II

This defendant is advised that Burton patent, 1,049,667 describes a process operated under high pressure amounting from about 4 to about 5 atmospheres. HM #1 and HM #2 operations employ pressures which are in some cases as low as 150 pounds and in some cases as high as 375 pounds per square inch. If these pressures are equiva-

lent in the practice of the aforesaid Burton process to the pressures specified in the claims, then the methods defined in subdivisions 1 and 2 of this interrogatory are used in all of the operations of HM #1 and HM #2 and are included in plans and/or specifications approved for all of the Holmes-Manley Process licensees.

Interrogatory IV

This defendant is advised that Burton patent 1,105,961 describes a process in which a pressure of from about 4 to about 5 atmospheres is maintained on the liquid in the still. HM #1 and HM #2 operations employ pressures which are in some cases as low as 150 pounds and in some cases as high as 375 pounds per square inch. If these pressures are equivalent in the practice of the aforesaid Burton Process to the pressures specified in the claims, then the methods defined in sub-divisions 1 and 2 of this interrogatory are used in all of the operations of HM #1 and HM #2 and are included in plans and/or specifications approved for all of the Holmes-Manley Process licensees.

[fol. 82] Interrogatory VI

This defendant is advised that Clark patent 1,119,496 describes a process operated at a pressure of from about 3 to 7 atmospheres. If the use of pressures varying from 150 to 250 pounds per square inch are equivalent in the practice of the aforesaid Clark process to the pressures specified in claims 2 and 3, then the methods defined in subdivisions 2 and 3 of this interrogatory are used in HM #2 to a limited extent, and the answers to sub-divisions 2 and 3 are UL under HM #2 and Yes under Approval.

Interrogatory XXXI

This defendant is advised that the method defined in Ellis patent 1,415,232, claim 4, is used in all HM #1 and #2 operations and is included in plans and/or specifications approved for all of the Holmes-Manley process licensees, if "whereby further conversion of the hydrocarbon material is effected" is construed to cover a process characterized by the fact that the oil leaves the alongated

passageway when the conversion is in the incipient stage and substantially all of the conversion takes place in the enlarged chamber.

This defendant is advised that the method defined in claim 6 of said Ellis patent is used in all HM #1 and HM #2 operations and is included in plans and/or specifications approved for all of the Holmes-Manley process licensees if "passing the products of decomposition" is construed to cover—passing the heated products in an incipient stage of decomposition.

This defendant is advised that the method defined in claim 8 of said Ellis patent is used in all HM #1 and HM #2 operations and is included in plans and/or specifications approved for all Holmes-Manley process licensees if "holding the products of decomposition" and "further substantial conversion" are construed to cover a process characterized by the fact that the oil leaves the highly heated passageway when the conversion is in the incipient stage and substantially all of the conversion takes place outside of the long passage.

[fol. 83] Interrogatory XXXIII

This defendant is advised that Clark patent 1,410,797 describes a process in which oil is continuously withdrawn from a considerable body of oil maintained under cracking conditions of temperature and pressure, the pressure released from the withdrawn oil, and the light fractions distilled off from the withdrawn oil are returned to the oil body for further cracking therein. If intermittent or semi-continuous withdrawal of oil from a pressure still and the subsequent retreatment of the light fractions in other pressure units is equivalent in the practice of the aforesaid Clark process to the continuous withdrawal and the return of the lighter fractions to the oil body for further cracking, specified in claim 1 of said patent, then the method defined in sub-division 1 of this interrogatory is used in HM #2 operations to the limited extent explained in the original answer.

Interrogatory XXXVI

This defendant is advised that the apparatus defined in claim 9 of Adams patent 1,320,354 is used in both HM #1

and HM #2 and is included in the plans and/or specifications furnished to all Holmes-Manley Process licensees if "a heating member and an inclosed oil retaining receptacle" is construed to cover a pressure still having a heating coil adjacent to it and connected with it.

This defendant is advised that the apparatus defined in claims 17 and 24 of said Adams patent is used in both HM #1 and HM #2 and is included in plans and/or specifications approved for all Holmes-Manley process licensees if "the heater combined with said receptacle adapted to be maintained at a cracking temperature in contact with the oil therein" is construed to cover a pressure still and a heating coil connected to the still, through which the oil passes and is raised to a cracking temperature previous to its discharge into the still.

This defendant is advised that the apparatus defined in claim 23 of said Adams patent is used in both HM #1 and HM #2 and is included in plans and/or specifications ap- [fol. 84] proved for all Holmes-Manley Process licensees if "a heater adapted to be maintained at a cracking temperature while in contact with said oil under pressure" is construed to cover a pressure still and a heating coil connected to the still, through which the oil passes and is raised to a cracking temperature previous to its discharge into the still.

Interrogatory XLII

This defendant is advised that Manley patent 1,428,338 describes a vertical still, a separator, a supply pipe leading into the bottom of the still, a pipe for returning condensate from the separator to the supply pipe, and means for forcing the condensate into the bottom of the still.

HM #2 apparatus comprises a vertical still, a supply pipe, a preheating coil, a connection between the outlet of the coil and the bottom of the still, a separator, a connection from the separator to the introductory end of the coil, and means for positively forcing the oil into the supply pipe at the introductory end of the coil.

In other words, the condensate is directly forced with the charge into the bottom of the still.

If this arrangement is equivalent for the purposes of the Manley invention to the apparatus specified in claim 9,

then sub-division 9 of this interrogatory is used in all HM #2 operations and is included in plans and/or specifications approved for all Holmes-Manley process licensees.

Interrogatory XLVIII

This defendant is advised that Adams patent 1,461,017 describes a tubular vertical converter, the central portion of which is surrounded by a furnace which is used for the purpose of raising the oil to a cracking temperature, as it flows through the converter. The HM #1 and HM #2 apparatus consist of cylindrical vertical converters which are supplied with oil at a high temperature and are surrounded intermediate their ends with furnaces for the purpose of maintaining the temperature of the oil therein. [fol. 85] The converters are large and the oil remains in them for a considerable period of time during its passage therethrough and is cracked therein.

If this apparatus is the equivalent for the purposes of the Adams invention of that specified in claims 10, 11, 16, 18, 20 and 22, the apparatus specified in sub-divisions 10, 11, 16, 18, 20 and 22 of this interrogatory is used in all of the HM #1 and HM #2 operations and is included in plans and/or specifications approved for all Holmes-Manley process licensees.

Interrogatory XLIX

This defendant is advised that Manley patent 1,462,143 describes a process in which the condensate from the separator is positively forced into the supply pipe and thence into the bottom of the vertical cracking still. In the HM #2 operations the condensate from the separator is returned and forced into the introductory end of a high temperature heating coil and is forced into the bottom of the pressure still after it flows through the coil. In other words, the condensate from the separator returns to the bottom of the still indirectly through the heating coil. If this is construed to be the equivalent in the practice of the aforesaid Manley Process of positively forcing the condensate into the bottom of the still as specified in claims 7 and 8, then sub-divisions 7 and 8 of this interrogatory are used in all HM #2 operations and are included in plans

and/or specifications approved for all Holmes-Manley process licensees.

Interrogatory LIV

This defendant is advised that the processes or process steps defined in claims 9, 11 to 15 inclusive, and 17 of Hall patent 1,175,910 are used in all "Hall" operations if "the endo-thermic reaction" is construed to be a necessary result of following the other designated steps.

The Texas Company, by (Sd.) Amos L. Beaty, President.

[fol. 86] ANSWERS OF THE DEFENDANT GASOLINE PRODUCTS COMPANY, INCORPORATED, TO PETITIONER'S INTERROGATORIES FILED APRIL 3, 1925

This Defendant deems it necessary, in order to avoid misunderstanding, to state that in answering the interrogatories required to be answered by it, it has not assumed that the numbered paragraphs attached to the interrogatories are claims of Letters Patent and it has therefore, in making its answers, accorded to such paragraphs their plain and ordinary meaning as nearly as it could be determined and has not given consideration to any other matter which might have a bearing upon the meaning of said paragraphs were they considered to be claims of Letters Patent, such as the date of the application for the patent, its specification, the proceedings in the Patent Office and the prior art, and Petitioner's waiver of answers in the interrogatories under oath having been withdrawn by said Petitioner, this Defendant makes these answers under oath as follows:

Answer to interrogatory I. No.
II. No.
III. No.
IV. No.
V. No.
VI. No.
VII. No.
VIII. No.
IX. No.

X. No.
XI. No.
XII. No.
XIII. No.
XIV. No.
XV. No.
XVI. No.
XVII. No.
XVIII. No.
XIX. No.
XX. No.
XXI. No.
XXII. No.
XXIII. No.
XXIV. No.
XXV. No.
XXVI. No.
XXVII. No.
XXVIII. No.
XXIX. No.
XXX. No.

Answer to interrogatory XXXI. This defendant has embodied in plans and/or specifications approved by it or furnished by it to its licensees the processes described in paragraphs numbered 1, 2, 4, 5, 6, 7, 8, 9 and 10 to the extent and during the periods shown in the accompanying schedule marked "Exhibit A."

Answer to interrogatory XXXII. No.
XXXIII. No.
XXXIV. No.
XXXV. No.
XXXVI. No.
XXXVII. No.
XXXVIII. No.
XXXIX. No.
XL. No.
XLI. No.
XLII. No.
XLIII. No.
XLIV. No.
[fol. 87] XLV. No.
XLVI. No.
XLVII. No.

XLVIII. No.
XLIX. No.
L. No.
LI. No.
LII. No.
LIII. No.
LIV. No.
LV. No.
LVI. No.
LVII. No.

Answer to interrogatory LVIII. No.
LIX. No.
LX. No.
LXI. No.
LXII. No.

Answer to interrogatory LXIII. This defendant has used the apparatus described in this interrogatory to a limited extent only, in test runs. It has not been embodied in plans and/or specifications approved or furnished by this defendant to its licensees.

Answer to interrogatory LXIV. No.

Answer to interrogatory LXV. This defendant has embodied in plans and/or specifications approved by it or furnished by it to its licensees the apparatus described in this interrogatory for the periods of time and to the extent shown in the accompanying schedule marked "Exhibit A."

Answer to interrogatory LXVI. This defendant has embodied in plans and/or specifications approved by it or furnished by it to its licensees the processes described in this interrogatory during the periods and to the extent indicated by the attached schedule marked "Exhibit A."

Answer to Interrogatory LXVII. No.
LXVIII. No.
LXIX. No.
LXX. No.
LXXI. No.
LXXII. No.

Answer to interrogatory LXXIII. The concentration of acid to be used in the treatment of the gasoline-like ma- [fol. 88] terial resulting from the operations of this defendant's patented processes is not specified by this defendant in the plans and specifications approved or furnished by it to its licensees, and this defendant has not

sufficient authoritative information to enable it to answer this interrogatory.

Answer to interrogatory LXXIV. No.
LXXV. No.
LXXVI. No.
LXXVII. No.
LXXVIII. No.

Answer to interrogatory LXXXII. This defendant has entered into an agreement with the Texas Company whereby the Texas Company agreed to waive its minimum royalties and accept in lieu thereof one-half of the royalties actually collected by this defendant from the Atlantic Refining Company.

This defendant has entered into an agreement with the Texas Company whereby the Texas Company has agreed to waive its minimum royalties and accept in lieu thereof one-half of the royalties collected by this defendant from the Vacuum Oil Company.

This defendant has an agreement with the Texas Company whereby Thomas E. Scofield was approved as counsel in accordance with the provisions of paragraph 14 of the agreement between the Texas Company and this defendant dated January 26, 1923.

Answer to interrogatory LXXXIII. The agreements referred to in answer to interrogatory LXXXII are evidenced by letters, copies of which are attached hereto.

Gasoline Products Company, Inc.

[fol. 80]

EXHIBIT A

Gasoline Products Company, Inc., 52 Broadway, New York City

Schedule of Cross Cracking Units Licensed by Gasoline Products Company, Inc., Completed or Under Construction as of May 31, 1925

June 5, 1925

Licensee and location of Refinery	License Contract Dated	Total Units and Size (Bbls. Daily Capacity)		Total Daily Capacity in Bbls.	Commenced commercial operations in												Under Construction May 31, 1925	
					1921		1922		1923		1924		1925 Jan.-May					
					Units	Daily Capacity	Units	Daily Capacity	Units	Daily Capacity	Units	Daily Capacity	Units	Daily Capacity			Units	Daily Capacity
Indian Refining Co. Lawrenceville, Ill..	7-23-19 4-20-22	2	600	3200	1	600	..	.....	..	.....	1	600	..	.....			2	2000
	.....	2	1000	.....	..	....	..	.....	..	.....	..	.....	..	.....			..	.....
The Globe Oil & Refining Co. Blackwell, Okla...	1-16-22	1	600	600	..	....	1	600	..	.....	..	.....	..	.....			..	.....
Petroleum Refining Co. Latonia, Ky.....	1-18-22	1	600	600	..	....	1	600	..	.....	..	.....	..	.....			..	.....
The Pure Oil Company. Heath, Ohio	2- 6-22	4	600	2400	..	....	4	2400	..	.....	..	.....	..	.....			..	.....
Smith's Bluff, Texas	.....	26	600	15600	..	....	..	.....	..	.....	26	15600	..	.....			..	.....
Roxana Petroleum Corp. Wood River, Ill...	3-16-22	4	600	2400	..	....	2	1200	2	1200	..	.....	..	.....			..	.....

Sapulpa Refining Co.																			
Sapulpa, Okla....		5-12-22	6	600	3600	..	....	2	1200	4	2400	..	.....	..	.....	..	.....		
Sun Oil Company.																			
Marcus Hook, Pa..		8-14-22	2	600	....	..	....	..	.....	..	.....	..	.....	..	.....	..	.....		
		.....	4	1000	5200	..	....	..	.....	..	.....	6	5200	..	.....	..	.....		
Clayton Oil & Refining Co.																			
Dallas, Texas		10-19-22	2	600	....	..	....	..	.....	..	.....	..	.....	..	.....	..	.....		
		.....	2	1000	3200	..	....	..	.....	2	1200	2	2000	..	.....	..	.....		
Cory Bros & Co., Ltd.		11-28-22	..	....	....	..	....	..	.....	..	.....	..	.....	..	.....	..	.....		
Cardiff, Wales ...	(b)	7-29-24	2	1000	2000	..	....	..	.....	..	.....	..	.....	..	.....	2	2000		
[fol. 90]																			
Medway Oil & Storage Co., Ltd.																			
Isle of Grain, Kent		5-16-24	..	....	....	..	....	..	.....	..	.....	..	.....	..	.....	..	.....		
England	(b)	7-29-24	2	1000	2000	..	....	..	.....	..	.....	..	2000	..	.....	..	.....		
The Atlantic Refining Co.																			
Point Breeze, Pa...	(b)	10- 9-24	6	2000	....	..	....	..	.....	..	.....	..	.....	..	.....	..	.....		
Franklin, Pa.		.....	6	1000	18000	..	....	..	.....	..	.....	..	.....	..	.....	12	18000		
Pierce Petroleum Corp.																			
Sand Springs, Okla.	(b)	10-15-24	4	1000	4000	..	....	..	.....	..	.....	..	.....	..	.....	4	4000		
Standard Oil Co. of N. Y.																			
Stone & Fleming Works																			
Brooklyn, N. Y. ...	(b)	3-20-25	4	1000	4000	..	....	..	.....	..	.....	..	.....	..	.....	4	4000		

"Exhibit A"—Continued

Licensee and location of Refinery	License Contract Dated	Total Units and Size (Bbls. Daily Capacity)		Total Daily Capacity in Bbls.	Commenced commercial operations in: 1921 Units	1921 Daily Capacity	1922 Units	1922 Daily Capacity	1923 Units	1923 Daily Capacity	1924 Units	1924 Daily Capacity	1925 Jan.-May Units	1925 Jan.-May Daily Capacity	Under Construction May 31, 1925 Units	Under Construction May 31, 1925 Daily Capacity
Magnolia Petroleum Co. Beaumont, Texas.	(b) 3-20-25	10	1000	10000	..	....	..	.....	..	.....	..	.....	..	.....	10	10000
Vacuum Oil Company. Olean, N. Y.	(b) -5- 1-25	1	1000	1000	..	....	..	.....	..	.....	..	.....	..	.....	1	1000
Totals		106		91200	1	600	10	6000	13	8200	45	33400	2	2000	85	41000

(a) License contract has been cancelled.
(b) License contract not enumerated in Petition.

[fol. 91]

Waite-Phillips Co. Okmulgee, Okla...	12-19-22	2	600	1200	..	....	..	.....	2	1200	..	.....	..	.....	..	.....
Miller Petroleum Corp. Humboldt, Kan....	2-17-23	1	600	....	..	....	..	.....	1	600	..	.....	..	.....	..	.....
Wichita Falls, Texas	.....	1	600	1200	..	....	..	.....	1	600	..	.....	..	.....	..	.....
Waverly Oil Works Co. Pittsburgh, Pa....	3-31-23	1	1000	1000	..	....	..	.....	1	1000	..	.....	..	.....	..	.....
Skelly Oil Company, El Dorado, Kan...	4- 4-23	2	1000	2000	..	....	..	.....	...	.....	2	2000	..	.....	..	.....

The British Burmah Pet. Co., Ltd., Rangoon, India.... (b)	5- 1-23	..	....	....	..	....	..	.....	..	.....	..	.....	..	.....	..	.....	..	.....	
	6-23-24	2	1000	2000	..	....	..	.....	..	.....	..	.....	2	2000	..	.....	..	.....	
Omaha Refining Company, Omaha, Neb.....(a)	5- 4-23	1	1000	1000	..	....	..	.....	..	.....	1	1000	..	.....	..	.....			
American Refining Co. Wichita Falls, Texas .....(a)	6- 4-23	2	1000	2000	..	....	..	.....	..	.....	2	2000	..	.....	..	.....			
U. S. Oil & Refining Co. Osage, Wyo.....	5-26-23	1	1000	1000	..	....	..	.....	..	.....	1	1000	..	.....	..	.....			
The British American Oil Co., Ltd. Toronto, Canada..(b)	2-15-24	1	1000	1000	..	....	..	.....	..	.....	1	1000	..	.....	..	.....			
Union Oil Co. of Cal. Wilmington, Cal..(b)	2-29-24	1	1000	1000	..	....	..	.....	..	.....	1	1000	..	.....	..	.....			

[fol. 92] ANSWER TO INTERROGATORIES BY DEFENDANT STANDARD OIL COMPANY OF NEW YORK

The defendant, Standard Oil Company of New York, answering the interrogatories propounded to it herein, for the purposes of this suit only and without taking into consideration and without reference to the specifications of the several patents appearing to be referred to in divers of the interrogatories, replies as follows:

Interrogatory.		Reply.
II.	1.-2.	Yes, at its Brooklyn refinery since 1914. Yes, at its Buffalo refinery since 1915. Yes, at its Providence refinery since 1921.
IV.	1.-2.	Yes, from time to time, but this is not a general practice at the refineries of the defendant. It has been principally used at the Buffalo refinery of the defendant.
VI.	1.-3.	No.
VII.	1.-2.	Yes, at all its refineries.
VIII.	1.-5.	Yes, at its Brooklyn and formerly at its Buffalo refinery.
IX.	1.-4.	Yes, as stated in VIII if the use of the false bottoms described in Interrogatory VIII are intended to be within the scope of Interrogatory IX, otherwise, no.
X.	1.-19.	No.
XI.	1.-6.	An installation was put in at its Buffalo refinery some years ago but has not been operated commercially there or elsewhere.
XII.		No, except perhaps what might be considered in a modified form for some years at its Brooklyn refinery.
XIII.	1.-4.	An installation was made some years ago at its Buffalo refinery but not commercially operated there or elsewhere.

[fol. 93]

Interrogatory.		Reply.
XIV.	1.-3.	Pobably not but there is room for divergence of opinion as to whether the apparatus used by the defendant at its refineries is within the description of this Interrogatory.
LXVII.	1.-8., 10.-22., and 25	Yes, but from time to time and at its different refineries defendant has varied the character of the operation with the varying commercial demand for the different constituents other than gasoline contained in the products and material described in this Interrogatory.
	9. and 10.	Only experimentally.
	23. and 24.	The apparatus described has not been installed at its Providence or its Brooklyn refinery. It was installed at its Buffalo refinery, was used for about five years, but is not now in use.
LXIX		The defendant has noted that there is a difference between the product of the cracking process and the gasoline produced from natural crude in the early stages of fractional distillation at a temperature somewhere below 500 and known in refining art as "sweet naphtha"; it has had no occasion to determine whether the "cracked" product differs from the product of the later stage of fractional distillation of natural crude known in the refining art as "gas naphtha."
LXXI.		No.
LXXII		Yes, all.
LXXIII		90 to 93 concentration, 66 Beaume.

Interrogatory.	Reply.
LXXIV	No.
LXXV	No.
LXXVI	To some extent.
LXXVIII	Not to the knowledge of the defendant under any deetrmination it has made.
[fol. 94]	
LXXXII	The defendant has entered into no such agreements other than the agreements listed in the bill of complaint and referred to in the answer except an agreement entered into since the filing of the answer.
LXXXIII	The defendant annexes a copy of the agreement of the defendant with the Standard Oil Company of Indiana referred to in its answer entered into on April 2nd, 1914, which was extended until the year 1919, and a copy of an agreement entered into with the Gasoline Products Company on or about March 20, 1925, under which it is not yet operating.

Standard Oil Company of New York

STIPULATION RE STANDARD OIL CO. (NEW YORK)

It is stipulated for the purpose of this suit, between the plaintiff and the defendant, Standard Oil Company of New York, that

I. The defendant, Standard Oil Company of New York does not claim to be carrying on, or to have at any time carried on the manufacture of gasoline under any of the patents mentioned in the interrogatories herein other than the patents specifically enumerated by patent number in the license agreements to which it is allged to be or to have been a party in the complaint herein, and the answer herein.

II. The plaintiff withdraws as to the defendant, Standard Oil Company of New York interrogatories number I; III; V; XV through LXVI; LXVIII; LXX and LXXVII.

[fol. 95] Ralph H. McKee, a witness called on behalf of the Petitioner, being first duly sworn, testified as follows:

Direct examination.

By Mr. Reuber:

My age is 52; I reside at 210 Christie Heights Avenue, Leona, New Jersey; I am Professor of Chemical Engineering, Columbia University, and Consulting Chemical Engineer.

A. I am a graduate of the College of Wooster, Wooster, Ohio, and a graduate of the University of Chicago. I have also had some training since then, in the University of Berlin.

I have numerous College and University degrees. At least, I have six of them, including Ph.D. and LL.D., two of which are honorary.

My familiarity with chemistry is practically due to my teaching of it since 1895, with the exception of two years, in which I was not teaching.

I have published a number of articles dealing with hydrocarbons and forms of petroleum, including a book, last year, entitled "Shale Oil", which was published at the request of the American Chemical Society, as one of their monographs.

I am the patentee of certain cracking processes, particularly one of which was used during the war, whose product was used not for motor fuel but was toluol—for the manufacture of T N T for war materials.

I have had working under my directions students interested in various phases of cracking operations, both from the theoretic side and from the practical side.

I have designed a plant for cracking purposes, and was operating vice-president in charge of operations. I have been consultant in a number of cases for corporations interested in hydrocarbon problems.

[fol. 96] I can show my general standing in the group, who know me best, that is, professional chemists and chemical engineers—by stating that I have been elected a member of the governing councils of practically all the societies which have to do with chemistry and chemical engineering in the United States.

I was Chairman for the United States, for two years, of the Society of Chemical Industry, and am at present a councillor at large, elected by the entire membership of the American Chemical Society.

I was, for two years, Chairman of the New York section of the American Chemical Society.

I am a member of several honorary societies of a technical character. I am a member of the Pi Kappa Phi, for general work. Tan Leta Pi for engineering, Phi Lambda Upsilon for Chemistry, and I think there are two more.

I have testified as an expert in a patent suit.

A. The early work on the cracking of petroleum, came about from the desire for illuminating oils rather than for motor fuels, because it was before the day of motor fuels, and we have, particularly preceding the drilling of the first petroleum oil in this country, by Col. Drake, some work in the United States, but much more in Europe, in this field.

The work in Europe was partially on oil from natural oil wells but largely on shale oil, a product possibly of identical origin and character?

The earliest work in this country, of which I have knowledge, was by Kier, a pharmacist of Pittsburgh who owned an oil spring not far from that locality, and he was selling it as a pharmaceutical product—as a crude oil, in a way, for bruises and such. But he didn't have a market for all of his product, and decided to try the purification of it, and make an illuminating oil out of it. He accomplished this by repeated distillations in an iron kettle. "He was unacquainted at that time with the modern method of purification by chemicals, but by repeated distillation he got a product which was useful as an illuminating oil, but which had an odor far more offensive than the original crude oil."

The fact that this is stated, and it was commonly spoken of, that this product had an oder far more offensive than [fol. 97] crude oil, shows to use of the present day, that he was cracking his product.

We have earlier citations of cracking, in Europe, where there were quite a number of schemes used for cracking which were discussed, but little used, and then we have some more detailed schemes of similar character, as we are using now, by cracking under pressure, and by treating and purifying the cracked product by acid, as well as those which were cracked with nothing but atmospheric pressure, and purification from chemicals, as we are using at the present day. So that the question of cracking dates back twenty-five years.

The Master: What do you mean by cracking?

The Witness: If we take any kind of an organic compound and heat it up, it will decompose. Some will decompose at one temperature, and others at higher temperatures.

If we take such compound as our present crude petroleum—particularly the heavier oil, and, I mean, by heavier oil, those that are heavier in gravity and which are also higher boiling—and heat them, we will decompose them into other products.

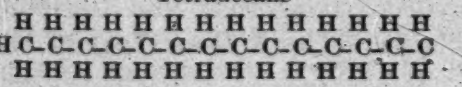
The Master: Why do you used the word cracking? Do you use it in the sense of the destruction of the molecular structure of the material that is being worked on, by heat and pressure?

The Witness: Yes, but not necessarily by pressure—always, pratically, by heat, and generally by pressure. And in that cracking you can have a breaking up of one molecule into two molecules, both of which may be oil; or into carbons, out of which may be oil, and part carbons and part gasses—such as hydrogen gas.

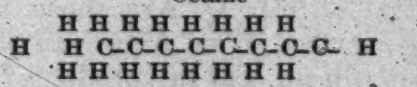
I have written out here—which I wish the stenographers to copy—an illustration of that.

[fol. 98] (The said table is as follows:)

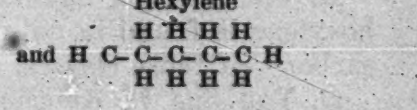
Tetradecane



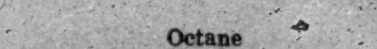
Octane



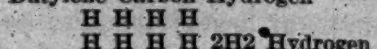
Hexylene



B. Tetradecane ----) Octane



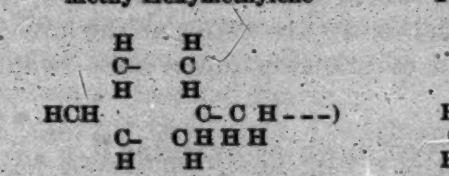
Butylene Carbon Hydrogen



and 2H2 Hydrogen and 2 C and

Methy-Hexymethylene Toluol

C.



C-C H3 and 3 H2

If we take Tetradecane, which is a Product present in straight run kerosene—and crack it, we might crack it into hydrocarbons having eight carbons, and six carbons such as Octane and non-saturated compound Hexylene, which would be as shown in equation A.

In this cracking, if we heat it to a still higher temperature, at a temperature at which it will decompose at a faster rate, we might decompose part of these products still further. In other words, re-crack them and we might get, as I have indicated in equatation B Octane and instead of Hexalene, Butylene, carbon and hydrogen, or there might be other products formed at the same time.

We have still a third character or type of cracking, which is particularly present when we use high temperatures, and when we use a raw material containing ring compounds, such as methyl-hexymethylene, as given in the equation C, where, by cracking we can get ring compounds similar to those we get in coal tar, such as toluol. And this is really the method by which benzol and toulol are obtained in coal tar.

This was a method which was used, to some extent, during war times, to get toluol from certain petroleums.

[fol. 99] Q. Are those hydrocarbons that you have described, from American petroleums as well as those of European coal tar products?

A. The starting materials are. I don't recall whether hexylene is found in natural petroleum or not, but hydrocarbons, of those classes, are.

Q. You find in American petroleums, largely, straight chain hydrocarbons—is that what you means?

A. Yes, though in some of the American petroleums we do find some ring compounds, but only comparatively few.

Q. Are the petroleums obtained from shale oils, straight chain hydrocarbons, also?

A. Yes, they are—they are practically identical, excepting the proportion of the ethylene compound or olefinic compounds, is much larger.

Q. Are both types of hydrocarbons found in the American and in the Scotch shale oil, or do they enter in different proportions?

A. The Scotch shale oil and the American petroleums differ in their primary proportions of these types, rather than in differences of more fundamental character.

The Master: When was the method of disrupting the molecular structure of fats and oils by the application of heat greater than atmospheric pressure, first known, to your knowledge?

The Witness: In Engler's work, of about 1893, I think, or 1888—it was 1888——

The Master: If the purpose of disrupting the structure of animal fat and vegetable oils by heat of more than atmospheric pressure, were known, would it suggest anything in refining processes of mineral oil?

The Witness: Yes, sir, for not only did they know it but they found that it gave actually the same hydrocarbons as were known in the mineral oils.

Q. In your preceding answer, did you have reference to the cracking of animal fat for the production of petroleum, relating to the work of Engler's?

A. Yes, sir. Engler's cracking of fish oil and getting petroleum was an artificial production of petroleum.

Q. To your knowledge, was the art of cracking petroleum known before Engler's work on fish oils and getting therefrom an artificial production of petroleum?

[fol. 100] A. It was.

Q. What is the difference in the character of the hydrocarbons in products from fish, or animal oils, and the petroleums?

A. Do you mean——

Q. General nature?

A. Of those present originally in the fish oils?

Q. Yes.

A. Those present in the petroleum are compounds of hydrogen and carbon, and we know them by the name hydrocarbons.

Those compounds present in fish oils, are almost exclusively compounds of glycerine, with certain organic acids, particularly oleic acid, and to a certain extent palmitic and steric acids. Both the glycerine and steric acid contain oxygen, so that fish oil is an oxygen containing product.

However, most of the constituents of the hydrocarbon oil made by Engler from fish oil were identical with those found in petroleum, the oxygen of the fish oil going off largely as carbondioxide, though to some extent as water, and other compounds.

The Master: If the whole process, as described in the Proctor and Gamble case for eliminating glycerine from gas and oil were pursued and applied to a mineral product, would you call that a mineral product?

The Witness: I don't recall that case.

Mr. Rauber: Wasn't that a case, your Honor, in which the glycerides were split into glycerine and the acid, by superheated steam?

Mr. Wiles: It is a fat splitting process.

The Witness: In using the word "cracking" in its broadest kind of sense, such would be a cracking process, though it is not a cracking process in the sense in which the word "cracking" is commonly used. That is, cracking is ordinarily used where in the molecules one carbon atom splits from another carbon atom, and the process you mention, on the other hand, is a splitting at an oxygen atom, and is a much easier process to accomplish.

Q. In general, what is the nature of the change when you crack straight chain hydrocarbons?

A. It is a breaking up into smaller straight chain hydrocarbon and generally a second straight chain hydrocarbon, although your cracking may reach—particularly when [fol. 101] carried on at high temperature, where it is a breaking up into one molecule of straight chain hydrocarbon, and the rest is a gas hydrogen, and a deposit of carbon.

Q. What is the difference between motor spirit and gasoline, and the original material that was started with?

A. Motor spirit is one which is volatile enough to be used without difficulty in the present-day automobile engine.

Q. I mean in regard to the hydrocarbon, and its form?

A. It is a material made up of smaller molecules, and, hence, more easily volatile.

Q. Is the gasoline obtained by cracking always the same as that obtained from the straight run distillation?

A. Only in part. One part of the carbon obtained by cracking is identical with that obtained from the straight run distillation, and part of it is often times, or is ordinarily materials which are not present in the original oil.

Q. These two parts that you speak of—they are not produced as separate parts, are they?

A. It is a mixture of the parts.

Q. In other words, the cracked gasoline contains substances that the straight run does not contain?

A. That is correct.

Q. What is the difference between a gasoline and a kerosene, so far as the size of the molecules is concerned?

A. In the case of gasoline, you have small sized molecules, as compared with kerosene. The distinction is really one of boiling point. That boiling below a certain point being generally spoken of as a gasoline constituent, and that above 255° C.—until you reach a still higher point—a kerosene. The gasoline compounds being the ones which have a small enough molecule to boil up to about 225 degrees Centigrade.

Mr. Wiles: If the Court please, I think we will save time if your Honor would request the witness to use Fahrenheit instead of Centigrade, because all the oil trade uses Fahrenheit, and we all use Fahrenheit, and it would only be an occasional scientific man that would not. If we have both the figures in the record we are going to have to do some calculating.

The Master: If he is able to do that, he might do it. If he is used to figuring in Centigrade, it might be more convenient for him to do that, and he will probably have to continue that way.

[fol 102] The Witness: I think I can do as requested. 225 degrees Centigrade is 437 degrees Fahrenheit.

Q. Has this relation, or division between gasoline and kerosene always been fixed?

A. No. In the early days we had to use for the low boiling products—for the products which we now call very volatile gasoline, and we have, perhaps, a good illustration of that——

The Master: What do you mean by saying that there was no demand for it? Do you mean that there was no commercial demand for it?

The Witness: No, there was none.

The Master: Wasn't there any commercial demand for naptha and benzine, in the dyeing art?

The Witness: I am speaking of benzine, instead of benzene. The light naptha, in the earlier days, was even thrown into rivers or into the ocean, because there was so little use for it. For example, in Crews treatise on Petroleum, on page 224, he states—in Europe:

"As there is very little demand for this light oil, comprising benzine, gasoline, and so forth, it is, in most instances, allowed to run into the sea."

That was published in 1887, and this represented the practice in Europe.

While there was some use for cleaning purposes, and for making gas, and for such purposes, the demand was very small, and, in consequence, the manufacturers of that date put as much of the gasoline into the kerosene, the burning oil, as the market would permit.

For example, quoting from the same volume, again, page 376:

"In ordinary oils the distillate was collected for these purposes, in the beginning at 56 degrees Baume. However, there was an oil made inferior to this, and largely sold"—I beg your pardon, the quotation begins with the word "Inferior."

"Inferior to this, and largely sold, at a lower fire test, of a pale straw color. This is generally made by mixing first runnings of light oils, running from 84 down to 56, where the flow is cut off, and the last running after the water's white ceases to come over."

In other words, the heavy kerosene was added to what is now good marketable gasolene—that between 64 and 66 degrees Baume—and was sold as burning oil. The market——

[fol. 103] The Master: You mean as an illuminating oil?

The Witness: Yes, sir. The Downer Refineries in Portland and Boston, which were two of the earliest refineries in America, put the cut paint at the same place as indicated by Leet, "Petroleum Distillatino," page 6, and only put the product distilling about 77 degrees Baume, as gasolene, page 66.

It was only in later years, considerably later than that that gasoline came onto the market for any large users.

Mr. Wiles: I didn't catch that about Leet. Did you say he put his out at 77?

The Witness: No, not his out—but his product averaged about 77 Baume.

Mr. Wiles: Gasolene?

The Witness: Gasolene. The exact quotation is:

"All that produces distillate at about 77 degrees Baume, may be classified as gasolene."

The first large use for gasolene came in in the uses of gasolene as a fuel for kitchen stoves, or so-called gasolene stoves to be used in the summer, and then that was followed by the present day use at a considerably later period, as a motor fuel, and it is only since gasolene was wanted as a motor fuel that the market has really wanted gasolene in larger proportions than the straight run gasolene would provide—that is, distillation without cracking.

Before that, the market demanded kerosene in larger amounts than the straight distillation would allow.

The Master: What do you mean by straight run gasoline?

The Witness: By straight run, we refer to simple distillation with or without the running in of steam simultaneously into the still, and it is accompanied by no cracking of the oil.

So that the earlier work of cracking, would concern itself, due to the commercial situation, almost exclusively with the cracking of oil to get illuminating oil, that is, kerosene. It was not known as kerosene in that day, however.

The Master: What do you mean by the running in of steam into the oil?

The Witness: In order to decrease the natural cracking which would occur when petroleum was, as ordinarily, distilled, we can hurry up that distillation by heat, and pre-

[fol. 104] vent the product from being long in contact with the heat, and thereby carry out the distillation at a somewhat lower temperature, if we run into the body of the oil, steam, at the same time we are carrying through the distillation. So that the resulting product coming over from the still is a mixture of the petroleum distillate and condensed water.

This is an advantage in speeding up the process, and particularly in decreasing the temperature at which the distillation takes places, and thereby decreasing the amount of cracking of the oil that would take place.

Q. In straight run distillations is it the purpose to separate from the mixture distilled the various products, at different boiling points?

A. Yes, to separate those that are present in the original oil, without the making of new products.

Q. Could a gasolene, or heavy naptha, have been obtained from the old type of kerosene, if there had been a demand for it, by straight run distillation?

A. Yes, sir.

Q. How could you determine whether a particular hyrocarbon belongs in a gasolene, or kerosene product, knowing its boiling temperature?

A. If it boils, at the present date, below 437°, it would belong in the gasolene fraction. In the earlier days, the temperature was not 437°, but was lower.

Q. Please describe, to the best of your knowledge, what the art, prior to 1907, taught as to the best methods, or methods of cracking hydro-carbon oils, reading from such patents such provisions as will illustrate those methods, and pointing out such diagrams as may be useful?

A. The art, prior to 1907, taught regarding the cracking of hydra-carbon oils referred to—that is, regarding the cracking of hydro-carbon oils to get low boiling products, in the then kerosene, and incidentally the gasolene [fol. 105] fractions—that it could be accomplished by bringing the oil into contact with a hot body, either by bringing the liquid into it, or as a gas—in other words, liquid phase or gas phase cracking.

One of the early schemes used in this country was where a still, without pressure, was air cooled at the top, and at the bottom heated but slowly, the point being that they

wanted a portion of the distillate to condense on the still top, and drop back into the body of the oil. When dropping back into this hot oil, it would gradually crack.

This method is a very slow method, several days being required to run a still charge of even a moderate size.

The chemical processes in general, are speeded up by increases of temperature. A difference of 20 degrees Fahrenheit, in general, doubles the speed of any chemical reaction that is brought about by heat, and accordingly the operator would like to raise it to a higher temperature.

It was well known, scientifically, that by putting a liquid under pressure, its boiling point would be raised, and in consequence we have the use of pressure as a scheme for raising the temperature, and hence speeding up the cracking process, coming in in these earlier times.

For example, James Young, in the British patent No. 2,345, of 1865, cracks in a still tested to at least a pressure of 100 pounds to the square inch, using, though, a lower pressure, preferably around 20 pounds to the square inch, and obtains cracking results by a speedier method.

Dewar & Redwood, in an American patent, No. 419,931, of January 21, 1890, described a cracking process in which they operate at——

Q. Well——

A. (continued). Page 1, line 73 "under high pressure," instead of being carried on at atmospheric pressure. This was for the cracking of oils in a similar way.

John Laing, in the Transactions of the Royal Scottish Society of Art, Volume 13, of 1894, on page 158, discusses the question of distillation under pressure, and also in the citation shows sketches of apparatus for carrying out the process.

I have in my list a total of seventeen citations operating under pressure, but unless you want them, I don't think it wise to go through all of them at this time. My point is only that operation under pressure was well known.

The Master: When?

[fol. 106] The Witness: Previous to 1907, and particularly in the years 1890 to 1900.

The Master: That is for operations on crude petroleum?

The Witness: Yes, sir, and on other similar hydro-carbons, to get products of burning oil kerosene, or products which could be used as present-day gasolene.

Q. When you say crude petroleum——

A. Not crude petroleum, I didn't mean—

The Master: I want to understand this. I want a clean-cut definition of cracking, which would be the term most used in this last instance all the way through. You used it a while ago, in a sense that would indicate that you included in the term cracking, the splitting off of gasolene by distillation, without pressure, at all. In other words, you referred to the old type of retort with air spaces at the top of it—holes at the top of it, with condensation at the top, and the dropping back of the condensate, and cracking ensuing.

That would seem to come within your definition of straight run gasoline.

The Witness: No, because in straight run gasolene it is a product obtained from the crude oil without change, and which was present in the crude oil, but it was only a method of separation—straight run distillation is only a method of separation. It is an attempt to separate the product which was present in the oil.

Cracking gives a new product a product which was not present in the oil which was put in the still.

The Master: You mean to say that it was not present in the product that was put into the still, but resulted from the decomposition of that product, and the rearrangement—

The Witness: Formed new chemical compounds—whereas in straight run distillation, the chemical compounds, which give the gasolene, when distilled, are present already, in the petroleum.

Q. You mean present as such?

A. Present as such, without having to undergo any chemical change.

It would be like the distillation of a mixture of alcohol and water. We can separate out the alcohol, and that would be similar to a straight run distillation.

However, on the other hand, if we carried it out under [fol. 107] such conditions as we could change that alcohol

to, say vinegar, acetic acid, that would not be a straight run distillation.

Chemical action would take place—not what corresponds to our cracking processes, but a somewhat analogous chemical change.

The Master: The disruption and rearrangement of that structure——

The Witness: Is necessary in cracking, but is not necessary in straight run distillation.

Q. In straight run distillation, do you sometimes have cracking as an incident?

A. Yes, sir, particularly if it is carried to the higher constituents, so that the heavier oil is carried over.

Q. Would cracking then be largely a matter of degrees or——

A. It would be only a small amount.

The Master: Pursuing your chronological account—I didn't mean to interrupt you, but it is necessary to get these things clearly as we go along. We may overlook them, and there might be a lapse in our understanding. I don't know that I can understand it, but I want to try to, as we go along.

Q. Were the gasolene products resulting, or the other products resulting from the cracking process which you have described, identical in all respects with American petroleum—that is, identical otherwise than in boiling point—or were there certain differences, to your knowledge?

A. The products were essentially similar, except that they carried more of the so-called unsaturated compounds belonging to the olefinic series.

Q. Will you please point out and describe in some of the prior art, the description of those gasolene products?

A. In an article by Thorpe and Coung, in the proceedings of the Royal Society of London, in Volume 20, beginning on page 488, we have a discussion of the product [fol. 108] obtained by the "combined action of heat and pressure upon the paraffins."

This is a cracking process which they have described earlier, but which, in this article, they describe the product obtained, and they show that they obtained pentane,

hexane, heptane, octane, nonane, and the similar unsaturated hydrocarbons. These pentane to nonane hydrocarbons are exactly those which have been isolated from the petroleum gasolene made from straight run distillation of Pennsylvania petroleum.

They also show that they obtained the olefinic hydrocarbons, having, in the same way, five to nine carbon stems, and indicated their percentages.

There was roughly half of each—the unsaturated and the saturated.

Q. Will you, please, describe by means of diagrams, or otherwise, the difference between the saturated and the unsaturated straight chain hydro-carbon?

A. In a saturated hydro-carbon, we have each of the four valences, which the carbon has, attached to different atoms. For example, in ethane we have each of the carbon atoms, attached to three hydrogen atoms, and one carbon atom, and that is one of the simplest of the saturated hydrocarbons.

When we go into the similar one of olefinic type or unsaturatel hydro-carbons, we have, again, two carbon atoms to each of which is attached two hydrogen atoms, and it has two of its valences attached to another carbon atom.

That is true when we come to any of the higher numbers —they will have two, or possibly more, carbon atoms—I will say one, or possibly more pairs of carbon atoms joined by two valances—that is, by two points of union.

Using present-day theoretic chemistry as an explanation, we would say that of the electrons which each carbon atom carries, in the saturated hydro-carbon we have a loss of one electron to an adjacent carbon atom, bringing about a single union. Whereas, in the unsaturated, we have a movement of two electrons from one carbon atom to an adjacent.

The hydro-carbons which we are most familiar with are those of the unsaturated series, and in the petroleum industry it happened that the Pennsylvania petroleum, which was the one best known, was composed almost entirely of such saturated hydro-carbons. We can have also either types of unsaturated carbons beside the olefic ones I have [fol. 109] mentioned. For example, ordinary acetylene is one in which there are three valences between the carbons,

and it is however not present in petroleum. Bensol derivatives, we have particularly in the Russian, and to an extent, in the California oils, ring-forms, in which we have say six atom rings, carrying on each carbon atom, two hydrogens and sometimes other groups in place of hydrogens, and these, on heating and cracking, will give us products such as benzol or a higer member of the series, toluol. When they change into benzol and toluol, we then have them as unsaturated hydrocarbons, consisting of three pairs of carbon atoms joined by two double bonds, and the pairs themselves joined together in the benzol formula by the single valences. This is also an unsaturated, though not the kind which we are most concerned with in petroleum work, the olefinic ones being together with the saturated hydro-carbons those with which we are most concerned.

Q. In general, then, the saturated hydro-carbons are those that have only a single bond between each neighboring carbon atom: is that the case?

A. That is correct.

Q. What is the characteristic of this double bond that distinguishes it from the straight single bond, as far as chemical reactions are concerned?

A. The straight single bond compounds are very stable. They are unreacting in fact, the name "parafines" used particularly for this class of hydrocarbons, means little chemical affinity.

The double bond compounds though are fairly reactive. They will combine with many substances. They will decompose more readily, and in general, have many more chemical reactions than the saturated ones or parafines.

Q. Can you readily distinguish between the unsaturated and the saturated hydro-carbons or determine whether unsaturated hydrocarbons are present?

A. The three tests that are commonly made and which give fairly accurate results, are the action of strong sulphuric acid, the action of bromine, or the action of iodine, and these are known as the sulphuric acid test, the bromine number, or the iodine number. The parafine hydrocarbon having zero solubility of sulphuric acid, and a zero bromine number and a zero iodine number.

Q. If you had a mix-ure of saturated and unsaturated [fol. 110] hydro-carbon, how would you proceed to deter-

mine their proportions by means of the sulphuric acid test?

A. The ordinary method is to mix product with strong, that is, 66 degree Baume sulphuric acid, and if we expect to have a considerable amount of unsaturated compounds, we would even use twice the volume of sulphuric acid of our oil sample. These would be mixed and not allowed to heat up overly, that is, by cooling, keeping it somewhere near room temperature, shaken thoroughly, and then perhaps contrifuged, and the volume that stands above read off by any means say by putting it into a vessel to start with, which was a graduated vessel. The volume above would be the amount of saturated hydro-carbons, and the loss of volume would be the volume of unsaturated hydro-carbons.

Q. By loss of volume, where do the unsaturated carbons go?

A. They dissolve in the sulphuric acid, combining chemically with it.

Q. What do you mean by the iodine number?

A. It is the amount of iodine that will combine with 100 grams of the material.

Q. How do you determine the iodine number in general terms; what is the general nature of the determination

A. The iodine number and the bromine number are determined similarly. The bromine number in fact is more commonly used than the iodine number, and I can answer your question a little easier by answering for the bromine number, and if you want, you can calculate the other without difficulty. For bromine number, the bromine is dissolved in carbon bisulphide as a solvent, and the petroleum is dissolved in carbon bisulphide.

The carbon bisulphide used, you have to have dry. The two are mixed, allowed to stand a few minutes, and are then poured, into a vessel of water.

We should have enough bromine, so that there would be a red color showing there was an excess of bromine. Then the mixture is poured into water, and the excess of bromine present determined by means of titration with sodium thiosulfate in the presence of potassium iodide. The blank is run, using the same amount of bromine solution in the carbon bisulphide, and the difference in the two is the amount that the defines and other unsaturated hydro-

carbons present in the petroleum have used up. That amount when calculated on to the weight of sample taken [fol. 111] of petroleum, permits you to get by proportion the amount of bromine which would be absorbed by 100 grams of the sample, add that would be the bromine number. The iodine number can be readily canculated from the bromine number. It is a proportion of their atomic weights, 128 to 80, so that it is roughly about one and six-tenths more.

Q. That is, the iodine number for any product is one and six-tenths more than the bromine number?

A. Yes.

Q. What general relation is there between the iodine and bromine numbers and the quantity of unsaturated hydro-carbons?

A. The larger the iodine number, or the larger the bromine number, the larger the amount of unsaturated hydro-carbons present in the sample.

Q. If you knew the exact proportions of unsaturated and saturated hydro-carbons, and also the number of carbon atoms in the hydró-carbon, can you calculate roughly the iodine and bromine number?

A. Yes.

Q. What is the volatility of a motor spirit, and how do you determine or measure the relative volatility of gasoline or motor spirits?

A. The measurement is made by determining the temperatures at which the sample begins to boil, and at which the last portion of the sample comes over. There are in certain specifications, limits at which 50 per cent. or 90 per cent. come over. The earlier specifications, however, do not have those intermediate limits.

Q. If one gasoline product had a lower boiling point than another, would you say it had a higher volatility or lower?

A. It has a higher volatility.

Q. What do you mean by the specific gravity of the gasoline or motor spirit?

A. The specific gravity of a substance is the weight of a certain volume of it compared with the weight of the same volume of water. For exact work, those are determined at particular temperatures.

Q. How do you determine the specific gravity for commercial purposes of gasoline?

A. For commercial purposes, the simplest way is to in- [fol. 112] sert into the liquid which is to be measured, that is, say whose specific gravity is to be determined, an instrument known as a hydrometer. As the hydrometer has a definite and unchangeable weight, it will sink further into a light liquid than it will into heavy liquid. This hydrometer carries, marked on the stem, a scale, and you can read from the scale the specific gravity of the liquid which you are measuring, or as in this industry, we often make these measurements not in the scientific specific gravity, where water is 1,000, but in Baume degrees, which is simply a trade scheme of making a similar determination, each Baume degree representing a specific gravity. It is made, because in factory work we find that workmen ordinarily can not carry in mind more than two figures at a time, such as 56 or 58, instead of the long series of four figures of specific gravity.

Q. Speaking of Baume degrees, how does the size of the number compare with the specific gravity?

A. There are two Baume scales; one for liquids, heavier than water; and one for liquids, lighter than water. For materials, such as sulphuric acid, we use the scale which is for heavier than water, and the larger the number the further it is away from the water, that is, the higher the density. In the case of oils we normally use the Baume scale, which is for lighter than water liquids, and again, the larger the number, the further away it is from the density of water; for example, a 77 degree Baume gasoline, will be a much lighter gasoline, that is, weigh less per gallon, than 60 degree Baume gasoline.

Q. In comparing products of straight-run distillation from the same petroleum, what, if any, relation is there between the specific gravity and the volatility or boiling points?

A. The higher the Baume reading, that is, the lower the specific gravity, the lower boiling point, for products of a given general type.

Q. That is a gasoline would have a lower specific gravity and lower boiling point than a heavier hydro-carbon?

A. Yes.

Q. Will you please compare the disclosures of this Ellis patent No. 1,318,060, particularly with reference to the product disclosed, with the disclosures of the art prior to 1913, pointing out and quoting those portions of the prior art that may illustrate the comparison?

[fol. 113] A. Ellis describes a method of cracking oil and concerns himself primarily, however, with a method of treating the oil with diluted sulphuric acid as a method of purification to get what he describes as a new product. I have gone into the question of the character of this new product and as to where I might find similar products described. In particular, his product is a fairly highly unsaturated hydro-carbon, or rather, contains considerable amounts of fairly highly unsaturated hydro-carbons, and this is shown by the iodine number of the carbon. I find, for example, the citation from the same Thorpe from which I read from earlier this morning, of an article by Thorpe in the proceedings of the Royal Society of London, Volume 19, pages 370 and 371, Exhibit No. 4, where he describes a cracked oil product of which approximately one-third boils below 200 degrees, and which he states that of the portion boiling below 100 degrees, it is mainly composed of olefins, and he also discusses some of the other fractions, but does not discuss them so definitely in this article as he does in a later article. This high grade gasoline, as it would be, boiling as it does below 200 degrees C., that is, 392 F. would mean a product havoing an iodine number of well, larger than that specified by Ellis. In fact, if we take his "by far the greater portion" which is on line 10 on page 371 as two-thirds, then the iodine number of that fraction would be approximately 203, if the unsaturated compound be taken as C_6H_{12} hexane, which would be an average constituent of such a portion. A second citation is from the same journal, Volume 21, of 1873. On page 184, we have the beginning of the article by Thorpe and Young. "On the combined action of heat and pressure upon the paraffines." This is again a case where he has cracked the oil under pressure, the pressure used being about 20 to 25 pounds, as shown on page 187, line 18, and refined by distilling over sodium. He isolated from this the number of the hydro-carbons, hexane, hepane, and others, and then determined from those various fractions, before isolating

the individual hydro-carbons, the amounts of unsaturated hydro-carbons present. In general, it is approximately one-half. In some cases, as on page 191, it is slightly more than one-half, according to the experimented work, but he believes this to be a little above the truth, and that is, that the amount of hepthalene found is perhaps greater than was really present according to his experiment. One fraction would be that boiling between 65 and 68 C, roughly 150 F. would have an iodine number of 152. The portion which contains the hepthalene and heptene would have an iodine number of about 131. The portion boiling at approximately 248 degrees, would have an iodine number of about 126, and similar for the higher bioling fractions, approximately half being present as unsaturated hydro-carbons in each case. This would mean a cracked gasoline of the ordinary type, as also is the Ellis gasoline in my opinion. Riebeck, German patent, No. 37,728, of February 28, 1885, discloses a distillation under pressure, with a view of producing increased quantities of low boiling oils. He uses for crude petroleum and residues two to four atmospheres, line 10 of the second column, page 1. I find I was [fol. 114] in error in giving the pressure used at that point. It is two to four atmospheres. It is on the second page, line 18, the first column, which is given as pressures of about three atmospheres. He obtains distillates which are of the kerosene type, that is, judging from the Baume, and obtains an easily mobile fluid of gravity of about 0.800 Riebeck does not describe his products in terms of unsaturatedness, but his starting material is the same as Ellis. The process is the same, the temperature about the same, and accordingly, we would expect the same character of products. He does describe it in other ways, but not in terms of unsaturatedness, that is in iodine numbers.

Engler, in an article in the proceedings of the German Chemical Society, an article in the Berichte der Deutschen Chemischen Gesellschaft, Volume 30, of 1897, pages 2919 and 2920, describes the product of the patent by the Kray process, the German patent No. 37,728, which is obtained by pressure distillation, and is highly unsaturated. On page 2920, is given a typical analyses, as carrying from 41 per cent. to 44 per cent. of unsaturated compounds. Such compounds of course, would have quiet high iodine numbers,

having nmbers of approximately as high as 125. These iodine numbers, I may add, of course, are known from the fact that the oils are given as having 5 to 7 carbon atoms, i. e. are of gasoline boiling character.

Bassett in United States patent No. 65,866, of June 18, 1867, describes a product for carbureting gas, consisting of 5 parts of light petroleum spirit, and one part of a coal distillate of 25 to 30 Baume. This will be identical in part with that of the Ellis product, but it would not be of quite as high as an iodine number as some of the products which Ellis describes.

Boynton, in the Unites States Patent No. 58,054, of September 18, 1866, mixes naphtha from gas tar, that is, crude benzol from gar tar and straight run gasoline, and distills up to 350 degrees F. He uses this product not for a motor spirit, as motors were not known as that time, but for carbonating and enriching gas. This product would be a product of gasoline-like character, and due to the admixture of the products from coal tar, it would be of a distinctly unsaturated character, the exact percentage of it we can not calculate from the figures that he gives, but it would be in Ellis general range.

Walker, United States patent No. 978,953, of October 18, 1910, patent applied for January 21, 1909, describes the [fol. 115] product in column 2, line 57, page 1, as containing about 40 per cent. of olefines, and only about 60 per cent. of paraffines, its boiling ranges from 35 degrees to 125 degrees C. 35 degrees C. would be 95 degrees F., and 125 C. would be 257 degrees F. He further states:

"It is believed that its olefines range from 5 to 8 carbons and that they are primary in structure."

If we take his product as having an average of seven carbon atoms, our 40 per cent. then gives us an iodine number of 104, which would be well within the range mentioned by Ellis. A note in the Chemical News of 1877, page 140, by Cabot, discusses the conversion of normal paraffines into members of the benzol series.

This cracking method to give benzols, the author suggests is a possible method of manufacturing benzol. At one stage in the process, the material woudl be in part un-

cracked, and partly cracked, and if condensed would give a motor spirit, made up partly of unsaturates, that is, with an iodine number of fair size; at least a good deal more than 30, and probably as much as 150.

Williams, in the Chemical News, Volume 49, of 1884, page 197, has a short article on "The Fluid Hydro-Carbons Obtained by the Compression of Petroleum Gas"; this petroleum gas he refers to is obtained by the so-called Pintsch process of gas manufacture. Seven specimens were analyzed, and they carry from 24 to 65 per cent. of benzene and toluene. He also gives the gravities of these condensates, and they are within the ordinary range of gasoline gravities. Due to the presence of these large percentages of unsaturated hydro-carbons such as benzene, and toluol, we would have them highly unsaturated, but he does not give details as to the presence of other unsaturated hydro-carbons, though they were probably present from such a method of manufacture; and accordingly, we can not calculate with exactness the iodine number.

Allan's Chemical Organic Analysis, Volume 3, pages 1 to 7, 13, 106, to 110, 115 to 117, published in 1910, referring particularly to page 106, where he describes and compares in detail the Scottish shale oil and American petroleum, naphthas, gasoline and kerosene, the discussion being confined to products which were of commercial character, or [fol. 116] as he calls them, "marketable products," I believe. The well petroleum of gasoline character on page 108, which he here calls naphtha, using it in the English sense, as this is an English book, he states carries 75 per cent. of hepane and homologues, the remainder apparently olefines with distinct traces of aromatic hydrocarbon. If we calculate this on the basis of the average product being the heptone and heptene, that is, say seven carbon atom product, we would have an iodine number of 65, that is from gasoline obtained from American well petroleum, while the shale oil naptha has roughly 50 to 60 per cent. of heptene, that would be the unsaturated, and its homologues. It accordingly would have an iodine number twice that of the other. In other words, the iodine number may be approximately 130. I should add that this product could without question be marketed as gasoline, in

fact, was marketed as the product as he states is among "The leading commercial hydro-carbon products" obtained in that section. On page 110, we have the bromine number given, or rather it is given in definition of grams of bromine of 100 grams of sample for gasolines from American oil, or a naphtha of 18.3 and for the "gasolene," a still lower boiling naphtha, which was the then gasoline, but not our present gasoline, 17.9; the 18.3 corresponding to our present gasoline, the bromine number which would correspond to an iodine number of 29.2, that is about 30.

The shale naptha of 67.2 bromine number corresponds to an iodine number of 107.5. Vittenet has a French patent No. 329,076, of February 5, 1905. He discusses the process of chemical purification and de-oderization of petroleum oils and benzines. He agitates with a 78 per cent. sulphuric acid, that is, with a 60-degree Baume sulphuric acid. He removes the acid and washes successively with bisulphite of soda, caustic soda solution and water. An ordinary cracked gasoline made by any hydrogenic process would, by this process, be made into a modern motor spirit of commercial character. Starting with a commercial crude cracked gasoline, the processes of treatment are essentially the same as that of Ellis. That is, his use of the small amounts of partially diluted sulphuric acid, that is, 60 degree acid, and later with an acid solution of bisulphide of soda, then with the customary alkali and water treatment. No figures are given to permit one to calculate an iodine number, but the process is one which we would ex- [fol. 117] pect to give products of that kind. It is essentially the same process as is described by Ellis.

Armstrong and Miller, in the Journal of the London Chemical Society, Volume 49, pages 74 to 93—this is of 1896, show the use of diluted sulphuric acid. For example, page 76, lines 14 and 20, they first treat the hydrocarbons with "moderately diluted sulphuric acid 2 vol. acid, 1 vol. water." And later they treat (in line 20) "with strong acid—4:1." On the supposition that the purchased acid was oil of vitriol, 1.84, then the two to one strength would be 76 per cent., which is within the range mentioned by Ellis. The process is one in which cracking is at excep-

tionally high temperature, and consequently they get mostly gas; and in fact, it is the purpose of this cracking to get illuminating gas rather than a gasoline or burning oil; but incidentally they do get some hydro-carbons which they treat with dilute acid as a method of purification. It is a product of gasoline of the like character though low in aliphatic saturated carbons; in other words, not high saturated carbons.

By Mr. Rauber:

Q. In speaking of Reibeck's patent, you said it was distilled under a pressure of two or three or four atmospheres, as the case may be; what do you mean by pressure of a certain number of atmospheres?

A. An atmosphere is equivalent to the pressure of about 14.7 pounds, so that two atmospheres would be roughly 30 pounds; four atmospheres, 60 pounds pressure to a square inch.

Q. You mentioned also the term "aromatic hydro-carbons." Just what does this mean?

A. Aromatic hydro-carbons are the group of unsaturated hydro-carbons which I mentioned earlier as ring compounds, in which there is a six-atom ring, or a nucleus of six carbon atom rings, in which we ordinarily consider every alternate group of valences to be a double valence. Benzol and teluol are the commonest members of this series.

Q. Just how does the gravity of unsaturated compounds or benzol compare with the specific gravity of saturated compounds of the same boiling point range?

A. There are three series of common hydro-carbons. The saturated hydro-carbons. The olefenic series are straight chains hydrocarbons having a double bond, and are unsaturated. The ring compounds which may be considered the carbon atoms confined in a ring and joined to-
[fol. 118] gether. These differ in the relation between the boiling points and gravities. In general the boiling point for a compound having a given number of carbon atoms, is higher in the case of the parafins than in the case of the olefines. To illustrate the one having fourteen carbon atoms, which would be a kerosene-like product and present in straight run kerosene, it would have a boiling point of 252 degrees, whereas in the olefenic series, it would vary,

according to different authors from 240 to 246 degrees. Those are Centigrade. I will give them in Fahrenheit.

The paraffin hydro-carbon having fourteen carbon atoms would boil at 486 Degrees F., as compared with the olefenic hydro-carbon having fourteen carbon atoms of 469 degrees, a difference of 17 degrees. A typical gasoline hydrocarbon would be that carrying nine carbon atoms, and this nonane of the saturated series, boils at — degrees C., which would be 298 degrees F., and the corresponding one of the olefenic series was 139 degrees C., which would be 282 degrees F. The corresponding benzol product would boil, (the aromatic series) in general somewhat higher, so that we have in this kind of unsaturation, an increase of boiling point.

Q. In the same boiling point range, how do the specific gravities of the different products compare?

A. The heaviest are the aromatic compounds. The next heaviest the olefin, and the next heaviest, the parafin, which are saturated hydrocarbons.

Q. Taking two gasolines of the same boiling point range, one consisting mostly of saturated hydro-carbons, and the other containing large portions of unsaturated and benzol, which would be the heavier?

A. The one containing large percentages of unsaturated and benzol, either of those two constituents increasing the gravity.

Q. In those products described in Allen's Commercial Organic Analysis, they are spoken of as shale oil gasolines. Would you say that they are complex mixtures of hydro-carbons, and that they have a higher specific gravity, or larger specific gravity than ordinary American gasolines of the same boiling point range?

A. Yes.

Q. You mentioned in the case of some of these gasoline products that they had an iodine number considerably [fol. 119] above 100. How would you be able to reduce that iodine number, provided you had a sufficient quantity of saturated gasoline?

A. You could mix the two gasolines together, such as is commonly done, by the mixing of cracked gasoline with straight-run gasoline. That is a common commercial practice; so that our iodine number of the product would be low as compared with the iodine number of cracked gasoline, which is used as one of the staples for the maxing process.

Q. Where the shale oil gasolines that you have mentioned or described in the book, Allen's Commercial Organic Analysis—were they purified commercial products?

A. They were.

Q. Do you understand them to be free from resinous products?

A. Yes.

Q. Or products forming resinous products on exposure to air?

A. Yes.

Q. Would such resinous product or products becoming resinous on exposure to air, be removed by the treatment described, as applied to shale oil products?

A. That is, by sulphuric acid?

Q. Yes.

A. Yes.

Q. Were the unsaturated hydro-carbons that you have mentioned, as specifically disclosed in the above mentioned articles and patents, stable unsaturated hydro-carbons?

A. All those which were mentioned by name, were, I think that in some cases a crude product was also described, but I did not mention it directly in my testimony, though it is mentioned in the articles.

Q. Have you read, and do you understand the disclosures of the Burton patent, No. 1,049,667, granted January 7, 1913?

A. I have read and I understand it.

Q. I am handing you herewith a certified copy of the file wrapper and contents of Burton patent, No. 1,049,667, and ask you to refer to the affidavit by Robert E. Humphries.

Mr. Rauber: I hereby offer in evidence as Petitioner's Exhibit No. 169, a certified copy of the file wrapper and contents of the Burton patent No. 1,049,667, granted January 7, 1913.

The Master: I shall admit the file wrapper and contents.

Mr. Neave: I must object now, in order to prevent it being accepted generally.

The Master: Yes, as substantive proof of the art.

Mr. Neave: Or of what people said in their affidavit as to what the art was.

The Master: The objection is noted.

The file wrapper and contents were admitted in evidence and marked "Petitioner's Exhibit No. 169," and the same is returned herewith.

Q. I am handing you herewith the file wrapper and contents of patent No. 1,049,667, Petitioner's Exhibit No. 169, and point out an affidavit of Robert E. Humphries. Have you read, and do you understand this affidavit?

A. I have read and understand it.

[fol. 120] Q. Referring to page 5 of this affidavit, paragraph 2, what do you conclude as to the iodine numbers of the product described in that affidavit?

Mr. Neave: I object to that. This affidavit was given in the prosecution of an application for the present patent, and it has no connection with this Ellis patent, which we are discussing, at all.

The Master: I have let you introduce the file in evidence, but if you want to prove the product that results from practicing the Burton Process, there are ways by which you can prove it. This witness's opinion of what Mr. Humphreys said, I don't think would be proper. I think it is very far afield. I believe, however, that it might be admissible as against the Burton patent, and not admissible as to the Ellis patent.

The Master: On the theory that you are attacking the Burton patent, and without reference to the Ellis patent, I will let him answer.

A. This product has an iodine number of 97, as given by Humphreys, Chief Chemist of the Standard Oil Company of Indiana, at that time, in his affidavit.

The Master: I don't consider it as affecting the Ellis patent in the slightest degree. I only let him go into this, only in so far as it affects the Burton patent.

Q. The product to which you refer as having an iodine number of 97,—that was the product identified as the Burton product?

The Master: Burton said he had an iodine product that came within the definition of Ellis's patent. That would not affect Ellis, unless it was true.

Mr. Rauber: I now offer in evidence Petitioner's "Exhibit No. 170," the patent issued to Carleton Ellis, No. 1,315,060, October 7, 1919.

The said Ellis patent so ocered was admitted in evidence, marked "Exhibit No. 170," and the same is herewith returned.

Mr. Rauber: We offer in evidence now, as Petitioner's "Exhibit No. 171," the patent issued to William M. Burton, No. 1,167,884, patented January 11, 1916, for a petroleum product.

The said Burton patent, so offered, was admitted in evidence, marked "Exhibit No. 171," and the same is herewith returned.

[fol. 121] Q. Now, please compare the product disclosed in this patent as Burton's "Exhibit No. 171," with the product obtained in a straight run distillation of the American petroleum?

A. The product obtained in the Burton patent, under discussion, is a distillate obtained from the residue of a process which Burton has earlier patented under another patent number.

The residue left in this distillation, or cracking process, is then taken and re-distilled without pressure—the original cracking process being a process where it is distilled at approximately four atmospheres. The product obtained is of low viscosity for its gravity, and low viscosity corresponding to its boiling point, as compared with the straight run distillate, which had not been distilled.

It will be essentially of lower viscosity for the same gravity, but it will have essentially the same constituents but differing perhaps in amount—the cracking process leaving in somewhat larger amounts of olefinic material than would be left in by the old process of straight distillation.

It is rather a question of time and temperature than of the pressure under which the first distillation is carried out. A straight distillation is faster, and consequently there would be less cracking, though some cracking would take place in these heavy products, in the same way.

Q. What do you mean by viscosity as applied to products of this character?

A. Viscosity of a liquid may be said to be its thickness, using thickness in the sense of thick molasses—a product having a high viscosity. It is measured, normally, by comparing the rate at which a product such as oil, flows through an orifice, as compared with the time taken for a similar quantity of water to flow through that orifice. There are several instruments used for that, and which are used in various sections of the world.

The Master: There are differences in the nature of the viscosity of different materials, are there not?

The Witness: Yes, sir. It would be a property, just as boiling point, or gravity, or viscosity and coloring.

The Master: Viscosity is not to be confused with consistency?

The Witness: It is one way of measuring consistency, but not the only way. It is of particular interest when it comes to lubricating oil, and products of that kind.

Q. What is the Saybolt instrument?

A. The Saybolt instrument was one worked out by Mr. George Saybolt of the old Standard Oil Company, and used in their laboratories, but not on the market for a number of years. It is one which is covered by a patent.

Q. Is there any other viscosimeter commonly used in determining the viscosity of lubricating oil?

A. The Engler instrument was more used; and, probably at the present day, as much used as the Saybolt instrument. There are also various others.

Q. What influence does temperature have on viscosity?

A. Temperature decreases the viscosity of a liquid in practically all cases. In a few cases, like sulphur, it does not, but in others it almost universally decreases the viscosity by increase of temperature.

Q. To your knowledge is there any way by which you can estimate the viscosity of one liquid if you knew the temperature of another—that is, roughly?

A. Roughly, yes, but not exactly.

Q. What relation does the viscosity have to the specific gravity in hydrocarbons of the same series?

A. Generally the higher the specific gravity, the higher the viscosity.

Q. Please state whether or not, to your k-owledge the art, prior to 1915, disclosed a petroleum oil characterized

by the following approximate relation between its gravity and its viscosity: $.51x^2 + 106xy - 961x - 29y^2 - 244y - 53296 = 0$, where "x" is the viscosity at 100° F. according to the Saybolt viscosimeter and "y" the Baume gravity of the oil?

[fol. 122] A. Yes, it does disclose.

Q. Will you please point out, in the prior art, where such disclosures occur, reading excerpts wherever it may be necessary.

A. In such an equation it is necessary to consider what the limitations are, and if we take, accordingly, in the same Burton patent, lines 4 to 25, on page 2, where the gravity and viscosity are given by Saybolt, and calculate out, and find out how near they agree with this equation which is supposed to be a measurement of these oils, we find that the variations are plus and minus, but generally minus, and from minus 11613 and 10035 run to, in one case, plus 1324.

In other words, this equation is apparently given with an error of minus, nearly twelve thousand and plus nearly three hundred.

So that anything that agrees within those figures would be considered as agreeing with this equation.

I may add that on lines 30 to 43, of page 2 of the patent, oils are illustrated which do not agree with such equation, and they vary—the closest one is approximately ten times as far away as those which he says do agree—being one hundred and eighteen thousand, seven hundred and thirty four, when calculated according to this equation, and others missing it by as much as four hundred and ninety-seven thousand two hundred and sixty-six.

The Master: Let me ask you right there:

Will the process described in that specification, uniformly produce the equation?

The Witness: No, sir, I don't think it will, though it will within certain errors, providing you make the errors large enough, but the error must be an error of roughly 25 per cent., which is a very considerable error.

The Master: Is there a range of temperatures specified?

The Witness: No. The viscosities are taken—

The Master: No, no—I mean in the process of producing the product, are there ranges of temperatures and latitudes in the process?

The Witness: No, but——

Mr. Rauber: Wait a minute. Here it is.

The Master: If there are latitudes of time and pressure and temperatures, would that alter the equation?

The Witness: There is apparently no latitude, for it simply says the product is taken and distilled to dryness under atmospheric, or approximately atmospheric pressure, the distilled vapors being condensed in a water condenser, and led to a receiving drum.

In other words, it is simply an ordinary straight distillation, whose temperatures will vary as the distillation proceeds, getting higher toward the last. But it is only one kind of distillation.

Rebeck, German patent No. 37,728, on February 28, 1886, carries out a preliminary distillation of approximately the same character as Burton's, and has left as a residue, when 30 per cent. of the product has been distilled through the cracking still, a product with a viscosity of seven to ten Engler, and a specific gravity of .930 to .950, and he suggests that it forms a good lubricating oil.

In other words, he doesn't carry the distillation to quite the same degree as Burton does, as he only distills off 30 per cent., and yet he gets products whose viscosity and specific gravity are—if we change the viscosity from Engler to Saybolt, and if we change the specific gravity, .930 to .950. We would have the Saybolt viscosity as 239 and 342; and [fol. 123] the Baume's as 20 degrees Baume—or rather, 20.05 and 10.73 degrees. These viscosities correspond with these specific gravities. Calculating them out for the lower Baume, we have 10.73 degrees Baume, and Saybolt viscosity 239—this equation would give us—plus 12,144, which is practically the same as given—or it is in the same range as is given by the present patent itself. in the oils that he illustrates in the patent, where one of them differs by eleven thousand six hundred and thirteen instead of my twelve thousand one hundred and forty-four.

He also runs a distillate of 50 to 80 per cent. distillate and then takes the residue and uses it, but we do not have given us the viscosity of the products. Hence, we can not calculate according to this equation.

The second citation of interest in this connection, is Engler and Singer, Berichte der Deutschen Chemischen Gesselschaft, Volume 26, pages 1439 to 1451, of 1893,—

Engler is here concerned with the possible origin of petroleum from fish oil, and has proven that paraffin and lubricating oil are present in the heavier residues left on the cracking of fish oil. The gravities are not given, but by inference there is nothing abnormal in the way of gravities of these oils. They are, however, of quite low viscosity. For example, using water at 20 degrees Centigrade, which would be 68 degrees Fahrenheit, the pipette is graduated, and its viscosity is taken as one. An oil boiling 290 to 300 degrees Centigrade, which would be 572 Fahrenheit, gave at 50 to 60 degrees Centigrade, (122 to 140° F.) a specific viscosity of one and six-tenths.

Another boiling above 572 degrees Fahrenheit gave a specific viscosity of 3.4.

These are very low viscosities and would apparently be of the same character of oils as those described by Burton.

Unfortunately, no specific gravity or Baume figures are given, so that we can not calculate them in accordance with the equation in the Burton patent.

Another citation is that of Aisinman in an article on the cracking of petroleum, given in Samlung fur Chemischer and Chemisch—Technischer Vortrage, Volume 5, page 189, 204, 205 to 219.

Page 10 of the translation gives oils distilled over, as having a gravity of .800 to .900, and a viscosity of two to four Engler, at 200 degrees.

[fol. 124] Also he gives heavy products, line 22 of the same page of the translation, having a gravity of .905 to .930, with a viscosity of six to ten degrees Engler, measured at 20 degrees Centigrade, 68 Fahrenheit.

If we transform Engler viscosity to Saybolt's viscosity, and the gravities there, to Baume degrees gravity, we have oils which, in part, at least, are quite parallel to that of Burton's.

For example, the oil at specific gravity .900, would have a Baume gravity of 20.5, and an Engler viscosity of 2 degrees, and a Saybolt viscosity—and here I might add that it depends a little on what authority we use for transforming—whether we use Battle's, Lubricating Engineering handbook of 1916, or the Bureau of Standards Technology Papers, 110, Table 9—if we take this oil and make the transformation from Engler to Saybolt according to Battle, it has a minus value of minus 8,341. If we take it and make

our transformation according to the Bureau of Standards table, it has a plus value of 8,284, or an average value almost exactly within the formula, bringing it almost to zero.

The heavy oils with gravities of .905 and .930, do not come so close, the closest being plus 42,874, which is for 930 and 6 degrees Engler, and for 905 and 6 degrees, plus 26,569, they are somewhat more distant, although within nearly the same range.

I might add that there are other figures that might be given, but the question arises as to which gravity, and they do not come as near as these that I have quoted.

Q. Will you please state whether or not, to your knowledge, any of the above disclosures comprise a petroleum oil having a Baume gravity of approximately 15 degrees and a viscosity of approximately 130 degrees, as measured by the Saybolt viscosimeter, at 100 degrees F., and comprising a mixture of fractions, mainly of the paraffin series and having a Baume gravity varying approximately from 20 degrees to 10 degrees, and a corresponding viscosity ranging approximately from 50 to 200?

A. The Aisiman reference gives oils corresponding to the definition which you have just given. For example, on page 10, line 22 of the translation, he gives an oil having a Baume gravity of about 20 degrees, and a Saybolt at 100 degrees F., approximately, varying from 135 to about [fol. 125] 300, according to which authority you take for transforming your Engler viscosity to Saybolt's viscosity.

Q. Will you please state whether or not, to your knowledge, any of the art that you have just desc-ibed, will produce a petroleum, or discloses a petroleum product made by the following process: Distilling of oil having a boiling-point of upward of 500 degrees F., at a temperature from about 650 degrees to 850 degrees F., and under a pressure of upwards of three atmospheres, until about 65 per cent. of the oil has been distilled over, drawing off the residue from the pressure still, distilling the latter under approximately atmospheric pressure, and condensing and collecting the distillate?

A. The last reference I gave, Aisimman provides that the distillate, under pressure, at the first stage—and that I do not recall—I don't believe that Aisimman disclosed under pressure—the Rebech's residue process which I

mentioned in connection with your previous question, are essentially similar oils, but they have not been distilled at the last stage, but would have those boiling points.

Mr. Rauber: I offer in evidence a copy of the Burton patent No. 1,105,961, patented August 4, 1914, for the manufacture of gasoline, and offer it as Petitioner's Exhibit No. 174.

The said Petitioner's "Exhibit No. 174" was admitted in evidence, and the same is returned herewith.

Q. Have you read, and do you understand the disclosures of the Burton patent No. 1,105,961, Petitioner's Exhibit No. 174?

A. I have read it, and I understand it.

Q. Will you please compare the process of this Burton patent No. 1,105,961, with the process outlined in my last question, or next to the last question?

Mr. Wiles: I suppose, we will take the filing dates for the purpose of this hearing. I believe we have stipulated that, have we not?

Mr. Rauber: We are willing to so stipulate.

A. I understand that this process outlined that the two would be practically identical, in fact, they would be identical. If you follow the process of the later patent, you would be carrying out the process of the first patent.

By Mr. Rauber:

Q. How does the product defined in the above questions, compare with the shale oil lubricating products produced prior to 1915?

A. They are essentially of the same character.

Q. To what do you attribute the lower viscosity of heavy residues produced by pressure distillation?

A. In general, to the presence of olefinic products, that is, unsaturated hydrocarbons.

Q. Do the gasoline in similar products obtained from petroleum shale or their source, require chemical purification or treatment other than distillation before marketing; that is, chemical treatments?

A. In general, yes.

Q. What is the general nature of this chemical treatments?

A. The earliest treatment was physical treatment, that [fol. 126] of simply distilling and redistilling. Later came treatments with sulphuric acid, and another method that has been used was distillation over metallic sodium, and still others have been treated muriatic acid, and with other acids, and then following that generally a treatment with dilute alkali, and then washing with water. The present-day treatment, and practically the treatment for a generation, has been treatment with sulphuric acid, then with caustic soda solution, and then with water, and it may be distilled as a final step or not distilled, dependent on the product wanted.

The Master: What is the object of that treatment?

The Witness: The object of that treatment is particularly to remove products which will discolor on standing, and perhaps even take out color that is already present, and in some of these cases, particularly more severe cases, the product which would tend to gum up and give trouble in the carburetor of the motor due to the so-called resinifying constituents, in other words to take out the resinifying constituents.

The Master: And dispose of the odor?

The Witness: Yes, formerly odors were much more important than at present. We will stand for a good deal of odor in gasolene at the present day.

By Mr. Rauber:

Q. What was the strength of acid used prior to 1913, or were there strengths of acid used?

A. There were several strengths of acid used. The so-called brown sulphuric acid of England, which was about 63 or 64 degrees Baume; the oil of vitriol, which was a 66-degree Baume acid. The diluter sulphuric acid which was essentially a 60 degree sulphuric acid, that would be about 77 or 78 per cent. The use of other acids, such as hydrochloric acid, which would be about a 35 per cent. acid.

Q. What is the concentration in pure sulphuric acid, of an commercial acid of 66 degrees Baume?

A. It depends a little bit whether you are taking American or European practices, but it is in either case within a fraction of a per cent. of 93 per cent.

Q. And about what is the concentration in pure sulphuric acid of a commercial acid of 60 degrees Baume?

A. 78 per cent.

Q. Approximately?

A. Approximately, yes, 77 or 78. The degree Baume having slightly different meaning in Europe than it does in the United States.

[fol. 127] Q. If a cracked gasolene or gasolene containing considerable quantities of unsaturated or olefinic hydrocarbons is distilled with sodium, will that remove resinifying products?

A. I would judge from the results reported by authorities, that it would; in fact, I know it would. That is one of the methods, for example, for taking diolefinic material and causing it to polymerize. It is a method, for example, for making artificial rubber from those materials.

Q. What do you mean by "polymerize"?

A. Polymerize as applied in that case, and generally in chemical terms, means the combination of one molecule of material with another of the same material, and in general the resultant can be caused to break up into the original materials again, that is to depolymerize, though not always.

Q. Similar to resinifying in its general effects?

A. Yes.

Mr. Rauber: I offer in evidence patent of Carleton Ellis, No. 1,318,061, patented 1919, for a process of making motor fuel, as Petitioner's Exhibit No. 175.

The said Petitioner's "Exhibit No. 175" was admitted in evidence and same is returned herewith.

Q. Have you read, and do you understand the disclosures of Ellis patent No. 1,318,061, Petitioner's Exhibit No. 175?

A. I have read it, and I understand it.

Q. Will you please compare in general terms the disclosure of this Ellis patent, with the usual practice in the purification of oils, practiced prior to 1913?

A. The distinction from the usual practice prior to the date given, is that Ellis prefers to use 40 to 80 per cent. sulphuric acid, whereas, the general preference prior to that time was for 93 per cent. acid. There were, however,

a number of cases before that date, in which they used an acid of considerably less strength than 93 per cent.

The Master: Is there a specific advantage in using the lesser amount of sulphuric acid; and if so, what?

The Witness: There is a difference of opinion regarding it. By the use of lesser strength acid on your crude material, or oil, you get more available as a motor fuel, that is, of your crude gasoline say, of 100 gallons your losses would be only a small amount. On the other hand, you have to use considerably more acid, so that it goes to a balancing of the cost of the extra amount of acid with the saving of obtaining an extra amount of motor fuel.

[fol. 128] By Mr. Rauber:

Q. Suppose in using a concentrated sulphuric acid on a cracked gasolene, the gasolene itself should become colored; is there any way, to your knowledge, by which it could be reobtained as a water white distillate?

A. That often occurs, and it is obtained as a water white distillate by redistilling, the color remaining back in the still.

Q. It is not necessary then to use a dilute acid?

A. No, it is not.

Q. Will you please state whether or not to your knowledge, the art prior to 1913 disclosed a process of treating cracked gasolene like material containing unsaturated bodies with dilute sulphuric acid, and point out wherein such disclosures occur, as they do occur?

A. There are three such disclosures that I wish to point out. The first is that of Redwood in his Treatise on Petroleum, Volume 2, pages 431 and 432 and 437, published in 1896. He states there the use in one of these cases of an acid of specific gravity of 1.720, which would be a 78 and 92/100ths per cent. This is between the 70 and 80 per cent. acid strength suggested by Ellis. A part of the unsaturates are removed by this process, and consequently there is a loss of oil, but still there are considerable amounts of unsaturates which remain. Aisinmen in his article on the cracking of petroleum in the Saamlung Chemischer and Chemisch-de Chemischer Vortrage——

The Master: What is the date?

The Witness: Of 1900—uses on page 9 of the translation, line 30, the varying strength of sulphuric acid. These strengths, however, are not below 66 degrees Baume. Armstrong & Miller, in their article entitled "Cracking of Temperatures to Give Hyro-carbons", in the Journal of the London Chemical Society, Volume 49, pages 74 to 93 of 1886, use 76 per cent., and then 85 per cent. sulphuric acid on hydrocarbons, to remove part of the unsaturates. This is on page 76, lines 14 and 20. That is where they use ordinary sulphuric acid in successive treatments, and even in purifying with sulphuric acid, using two strengths of the sulphuric acid. For example, take 76, line 14. There 77 per cent. is not expressed in that form. It is as two volumes of acid to one volume of water, a mixture. In other words, they have gone to the trouble to dilute very strong acid, 93 per cent. acid, to get a dilute acid, so that it would not work too vigorously on the unsaturated hydrocarbons. [fol. 129] I have made a calculation that they started with a 66 degree acid, an acid of specific gravity 1.84. If, on the other hand, they started with the acid which was sold in even larger amounts in that time, in England, the brown acid which would mean a more dilute acid than this by three or four per cent., say around 72 per cent. of sulphuric acid.

Another reference is Letney in Dingler's Polytechnisshi Journal of 1878, pages 353 to 358. I refer particularly to page 3 of the translation, in which the fraction boiling between 80 to 200 degrees C. appears. That would be 176 degrees F. to 392 degrees F. which was treated with equal parts of sulphuric acid and water, and upon fractional distillation, they separated out certain hydrocarbons.

Q. I ask you to refer to page 358 of the article of Letney in the Dingler's Polytechnissi Journal, the second paragraph. Will you please read that?

The Master: Do you mean to read that into the record?

Mr. Rauber: That is already offered in evidence.

The Master: And you ask him to read it—you can call his attention to it and ask him questions about it.

Q. Yes. Do you find any disclosure of a treatment with a diluted sulphuric acid in that paragraph?

A. I find on page 358 in the second paragraph, a statement which, on translation would read: "The distillate distilling up to 226° was separated by crystallization from the other distillate and washed with sulphuric acid (diluted half and half with water, that is 50 per cent. water)".

Q. What result does he describe as being obtained by such treatment with 50 per cent. sulphuric acid?

A. "The resinous residue derived was separated from the transparent liquid by use of a separating pump." In other words, the product after such treatment was described here as a transparent liquid. The German corresponding to that described is "durchsichtigen", so it would be perhaps better translated "clear".

[fol. 130] It is stipulated between the Petitioner and the Defendant, The Texas Company, that uncertified printed Patent Office copies of United States and foreign patents and publications, or photographic copies thereof, and uncertified translations of foreign patents and publications, may be received in evidence in the above-entitled suit with the same force and effect as though certified and or proved, subject to objections as to relevancy and materiality and subject to correction, if error appear, and that the dates of issue appearing on the United States patents, the "ausgegeben" dates appearing on German patents, the dates of delivery appearing on French patents, the dates of sealing of British patents, and the dates of issue on all other patents, and the dates appearing on the publications, shall be taken, subject to correction, as the actual dates of publication or patenting without further proof; provided however, that nothing in this stipulation shall be construed as a waiver of the Defendant, The Texas Company, or of the Petitioner, to object to the competency, relevancy, materiality or admissibility, for any reason other than the lack of proper certification or proof of the documents thus offered, of the evidence to which this stipulation refers.

A similar stipulation was entered into between petitioner and Standard Oil Company (Ind.), Standard Oil Company (N. J.) and Gasoline Products Company.

Mr. Rauber: The Petitioner has prepared a chart, or table, from the Answers to the Interrogatories, and offers that chart, subject to correction by any of the interested parties, as "Petitioner's Exhibit No. 159." This chart

shows merely the tabulation of all the Answers of all the Defendants. It is offered subject to correction, also.

The said Chart, so offered, was admitted in evidence, was marked "Exhibit No. 159"

Mr. Rauber: The Petitioner offers as "Exhibit No. 160," a chart showing the Answers as copied from "Exhibit No. 159," omitting all reference to patents that are not stated to be used, or threatened, or equivalent terms, in the original Answers to Interrogatories.

There have, also, been omitted from this table all of the patents which are used only by the company that owns them.

Moreover, one patent has been omitted because its use has been abandoned by the company not owning the patent, and there is, at the present time, no company other than the owner, using that patent.

The Master: Would it not be well to designate what patent that is, that you are talking about?

Mr. Rauber: That is the Cash patent, No. 1,230,065, and there is an explanatory note at the bottom of that table.

For the purpose of showing the existence, subject matter, filing and issue dates of certain of Defendant's patents and without admitting the statements contained in said patents to be either true or accurate and without admitting the validity of the patents, Petitioner offers the following patents as exhibits, and requests that they be marked Petitioner's Exhibits Nos. 176 to 199, respectively:

[fol. 131] Burton, 1,049,667, Jan. 7, 1913,
Clark, 1,119,496, Dec. 1, 1914,
Humphreys, 1,119,700, Dec. 1, 1914,
Clark, 1,129,034, Feb. 6, 1915,
Hall, 1,175,909 Mar. 14, 1916,
Palmer, 1,187,380, June 30, 1916,
Chamberlain, 1,221,790, Apr. 3, 1917,
Hall, 1,242,795, Oct. 9, 1917,
Hall, 1,242,796, Oct. 9 1917,
Adams, 1,320,354, Oct. 28, 1919,
Adams, 1,320,726, Nov. 4, 1919,
Adams, 1,320,727, Nov. 4, 1919,
Adams, 1,327,263, Jan. 6, 1920,
Lewis & Cooke, 1,392,584, Oct. 4, 1921,

Clark, 1,410,797, Mar. 28, 1922,
Ellis, 1,396,999, Nov. 15, 1921,
Ellis, 1,415,232 May 9, 1922,
Cross, 1,423,500, July 18, 1922,
Adams, 1,433,519, Oct. 24, 1922,
Burton et al., 1,448,254, Mar. 13, 1923,
Adams, 1,461,017, July 3, 1923,
Manley, 1,462,143, July 17, 1923,
Adams, 1,462,677, July 24, 1923,
Adams, 1,462,678, July 24, 1923.

The purpose of this offer is the same as that for which the exhibits 170 to 175 were offered.

Petitioner offers in evidence certified copies of the file wrappers and contents of the following list of the Defendant's patents for the purpose of showing what took place in the Prosecution of the applications on which the respective patents were granted and without admitting the statements contained in said file wrapper to be either true or accurate:

Burton, 1,105,961, Aug. 4, 1914, Filed Aug. 25, 1913,
Clark, 1,119,496, Dec. 1, 1914, Filed Apr. 20, 1914,
Humphreys, 1,119,700, Dec. 1, 1914, Filed June 26, 1914,
Clark, 1,129,034, Feb. 16, 1915, Filed Apr. 20, 1914,
Hall, 1,175,909, Mar. 14, 1916, Filed July 24, 1914,
Palmer, 1,187,380, June 13, 1916, Filed Mar. 2, 1907,
Hall, 1,242,795, Oct. 9, 1917, Filed Mar. 12, 1914,
Hall, 1,242,796, Oct. 9, 1917, Filed Apr. 4, 1914,
Ellis, 1,318,060, Oct. 7, 1919, Filed Oct. 12, 1917,
Ellis, 1,318,061, Oct. 7, 1919, Filed Aug. 21, 1913,
Adams, 1,320,354, Oct. 28, 1919, Filed Dec. 1, 1909,
Adams, 1,320,726, Nov. 4, 1919, Filed Dec. 31, 1914,
Adams, 1,320,727, Nov. 4, 1919, Filed Mar. 29, 1915,
Adams, 1,327,263, Jan. 6, 1920, Filed Mar. 30, 1911,
Lewis & Cooke, 1,392,584, Oct. 4, 1921, Filed May 7, 1917,
Clark, 1,410,797, Mar. 28, 1922, Filed Apr. 21, 1919,
Ellis, 1,396,999, Nov. 15, 1921, Filed Oct. 4, 1913,
Ellis, 1,415,232, May 9, 1922, Filed Nov. 26, 1920,
Cross, 1,423,500, July 18, 1922, Filed May 2, 1921,
Adams, 1,433,519, Oct. 24, 1922, Filed Dec. 5, 1917,
Burton et al., 1,448,254, Mar. 13, 1922, Filed Mar. 2, 1916,
Adams, 1,461,017, July 3, 1923, Filed Dec. 5, 1917,

Manley, 1,462,143, July 17, 1923, Filed Oct. 10, 1917,
Adams, 1,462,677, July 24, 1923, Filed June 15, 1916,
Adams, 1,462,678, July 24, 1923, Filed June 15, 1916,
Burton, 1,167,884, Jany. 11 1916, Filed Feb. 20, 1915.

The purpose of this offer is thus the same as that for Petitioner's exhibit No. 169.

(These exhibits are omitted from the records on appeal.)

[fol. 132] Q. In your prior testimony, on October 12th, you mentioned straight run distillation at atmospheric pressure, and the cracking distillation at atmospheric pressure, and the effect of temperature, pressure and time.

How can you determine, from a description of the atmospheric distillation process, whether it is a process of cracking, or only a fractional distillation for the separation of products going into the distillation?

A. The essential elements which determine whether it is a cracking process, or only a straight distillation process, are time and temperature.

In a straight run distillation the attempt is made to remove the product, or vapors as the temperature rises, as rapidly as possible.

On the other hand, in the cracking process, the attempt is made to hold the product at the cracking temperature, as long as needed, to decompose them—to break them into lower—break the heavy oils into lower boiling products.

So that the essential end in the case of a cracking process at atmospheric pressure, will be, ordinarily, the same scheme of either returning the uncracked product to be heated and cracked, or by carrying out the process very slowly—that is, below the temperature at which the product would distil over, which it is wished to crack.

The context will, in general, show plainly what is wanted in the particular case—what is the thought of the author.

Q. In the atmospheric distillation, or distillation at atmospheric pressure, do both the cracking of some of the hydrocarbons and the distillation of other hydrocarbons, without cracking, occur simultaneously in the same still?

A. Yes. In all cases where we are distilling crude oil, in even straight distillation, we get some cracking. But it is attempted to keep it at a minimum, and, ordinarily, it

only occurs in a small amount. Whereas, in the case of desired cracking, we increase that amount to the maximum crackable.

Q. In straight run distillation for the separation of hydrocarbons, have measures ever been taken to lessen, or avoid cracking of the hydrocarbons when a separation, only, is desired?

A. Yes. For example, by putting the still under vacuum—which means that the material will boil at a lower temperature, and, consequently, it will not be heated to the same high temperature, to which it would be heated if it was at atmospheric pressure. So that the use of vacuum permits distillation to take place at a lower temperature, and, thereby decreases the amount of cracking.

Cracking, as I stated two weeks ago, is a chemical decomposition, which is increased by rise of temperature, ordinarily very close to the general record of chemical decompositions, where an increase of twenty degrees F. of temperature doubles the rate of chemical action—or, in this case, chemical decomposition—or, as we call it, in the oil trade, cra-king.

Q. Is the use of super-atmospheric pressures, or unnecessarily high pressures, in distillation, an indication that cracking has taken place, rather than distillation?

A. That is an indication that the purpose is to get cracking.

The Master: Do you differentiate between cracking and distillation?

Mr. Rauber: Yes, your Honor.

The Master: Do you?

The Witness: Yes, sir. For example, we can—

The Master: Define both the terms.

The Witness: If we take quite stable substances, we can by distillation, without appreciable cracking, separately obtain the different substances, particularly if we use a vacuum. Instead of a vacuum, we can use a current of steam, which has the same effect as a vacuum. These will be distillations. If we are using crude oils, we will get kerosene, or gasolene—without cracking, or with a very small amount of cracking. Whereas, if we would want to crack these oils we would put them under pressure, so that

we could handle them at higher temperatures, because an increase of pressure increases the boiling point, and thereby brings it to a higher temperature.

By such a method as the last we could get, for example, cracked kerosene and gasolene.

Q. In the cracking process carried out, either under pressure, or at atmospheric pressure, do you also have a distillation of some of the hydrocarbons, without cracking?

[fol. 133] A. If we would crack a crude oil at atmospheric pressure, we would have some of the crude oil distilling over, uncracked—particularly the low boiling portions—that is, the gasolines and kerosene constituents.

Q. If you were to crack a gas oil under pressure, or a kerosene under pressure, would you get any distillation of that along with the cracking?

A. Normally, yes, unless used with enormous pressures so that there would be no vapors going over while you were cracking.

If you crack and distill, at all, you would get some of the cracked products and some of the uncracked products going over. The amount of the uncracked, however, would be relatively small.

Q. In speaking of distilling, or cracking, do you have in mind rather a predominance of one or the other of these two operations?

A. Yes. You cannot carry out your distillation without cracking, using the ordinary gas oil, or crude oils. On the other hand you cannot carry out your cracking of these by any of the commercial methods, without, at the same time, having some distillation or unchanged constituents. So that it comes to the question as to which is the dominating influence.

Q. Since the last hearing, on October 12, have you read, and do you understand those portions of the decisions in Tilgman v. Proctor, reported in 102 U. S. page 707, and following, relating to the description of the Tilgman process?

A. I have.

Q. Will you please compare the chemical changes taking place in the Tilgman process with those of Engler, Young and others of the acid that you mentioned?

A. In the process under discussion, the Tilgman process referred to, we have there, a question of the splitting of the

fat into its constituents. These constituents are glycerine, and we may take the fatty acid as stearic acid. The glycerine, in such case, will appear as shown on the Chart A, which I desire to have copied in.

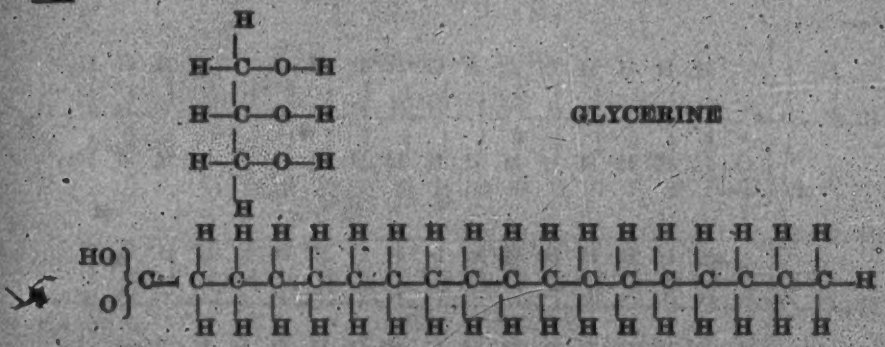
The Master: That is "Sheet A" of the diagram which you here produce?

The Witness: Yes.

"Sheet A" referred to by the witness, is as follows:

[fol. 134]

A



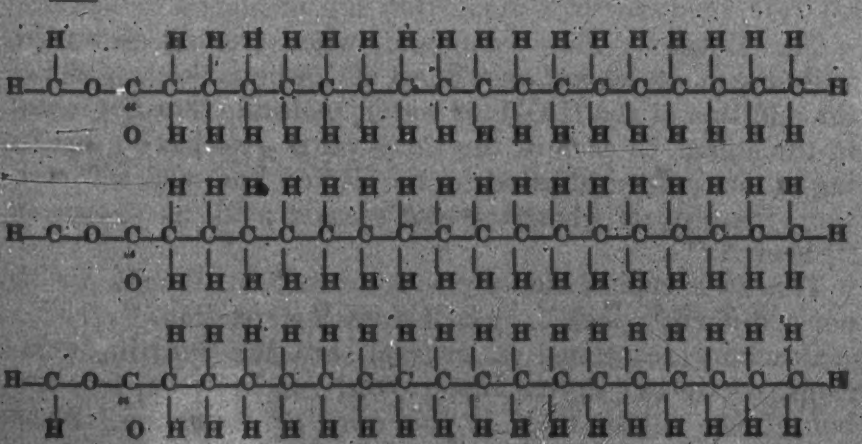
GLYCERINE

STEARIC ACID

The Witness: The glycerine has three O. H. groups joined to the carbons and we have in the fat, a compound of glycerine with the stearic acid, as shown on "Sheet B" which I hand to the reported to be copied in.

"Sheet B" is as follows:

B



GLYCERINE STEARATE

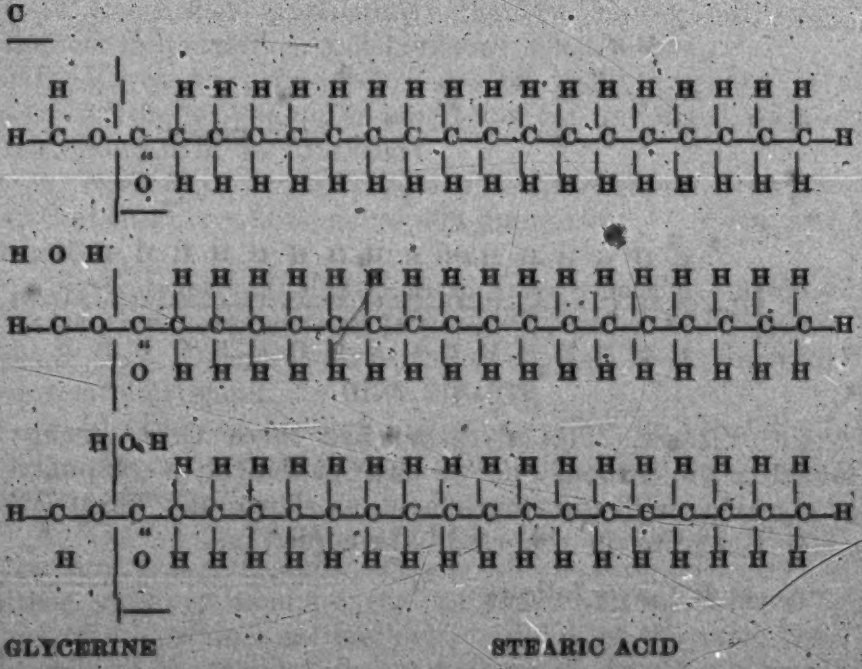
A FAT

[fol. 135] The Witness: On "Sheet B" is shown a complex formula, which would represent a typical fat—glycerine, stearic.

This compound, when treated with steam, as shown on "Sheet C", which I ask the reporter to copy in—

"Sheet C", is as follows:

TILGMAN'S REACTION



GLYCERINE STEARIC ACID

The Witness: This compound, when treated as stated, with steam, as shown on "Sheet C", where the line shows the addition of the H-OH, or water, molecule that is present in the steam, to each of the three parts—we have a breaking at the point indicated by the dotted line, and a formation, thereby, of glycerine and stearic acid, as shown on "Sheet A."

This is a typical decomposition reaction, though we do not ordinarily speak of it as a cracking reaction.

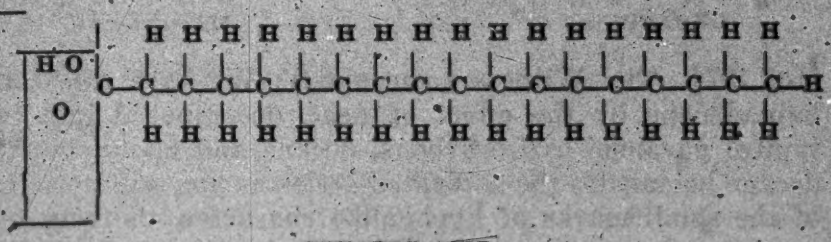
Cracking reactions, in general, are the splitting reactions, where our dotted lines would run between, two carbon atoms, rather than, in this case, as shown on "Sheet C", between the oxygen and carbon.

Now, passing on to the Engler Process, we have there, as shown on "Sheet D"—which I hand you herewith.

"Sheet D" is as follows:

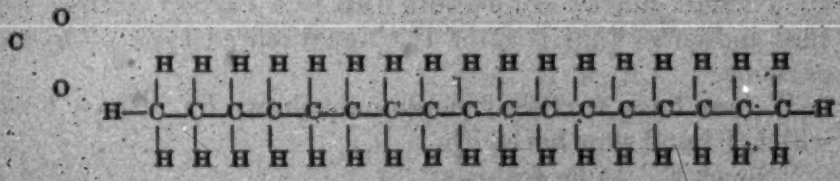
[fol. 136] ENGLER'S PROCESS

D



STEARIC ACID

PRODUCES



CARBON DIOXIDE

HEPTADECANE

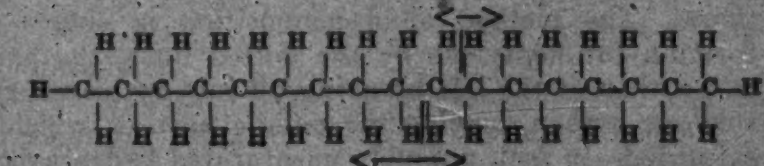
The Witness (continued): A decomposition of the stearic acid which was produced by the Tilgman's Process and a splitting out from it of carbon dioxide, or carbonic acid, leaving as a residue, a hydrocarbon, heptadecane, which would be a typical kerosene hydrocarbon, though present to some extent in gas oil, the products boiling above kerosene. This is the Engler Process—one step of the Engler process in which he got petroleum hydrocarbons starting from fish oil.

In the cracking process as shown on "Sheet E",—which I hand you herewith—

"Sheet E" is as follows:

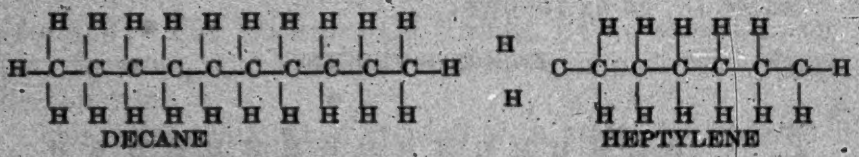
CRACKING PROCESS

E



HEPTADECANE

PRODUCES

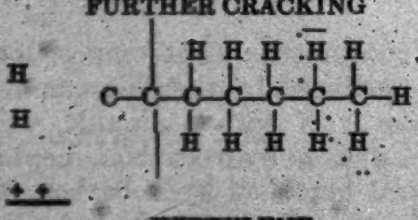


[fol. 137] The Witness (continued): We have this same heptadecane by the effect of heat, decomposed into two typical gasolene hydrocarbons, decane and heptylene; the decane belongs to the saturated series as you will note that of the small marks of hyphenlike character, there is only one between any two carbon atoms, whereas, the heptylene shown to the right on this "Sheet E" has, in one case, two such small marks connecting the two carbon atoms, and that indicates that it is of the unsaturated type of hydrocarbons.

We can have further cracking, as shown on "Sheet F"—which I hand you herewith.

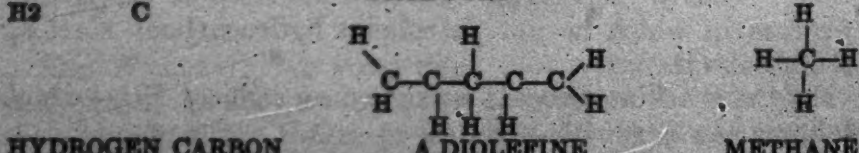
"Sheet F", is as follows:

FURTHER CRACKING



HEPTYLENE

PRODUCES



The Witness (continued): In which the product which we had on "Sheet E", heptylene is broken up still further into the products, hydrogen, carbon, a diolefine and methane. The method of decomposition is shown in the formula for heptylene by the dotted lines, the hydrogen and carbon at the left breaking off into hydrogen gas and coke, or carbon, leaving the middle portion, which is unsaturated—in fact, a doubly unsaturated hydrocarbon, and

the right end producing a typical gas, methane, a gas obtained in many cracking processes.

Q. In your description of these processes, you have mentioned certain unsaturated hydrocarbons. Will you please explain how bromine reacts with these hydrocarbons in finding the bromine or iodine numbers.

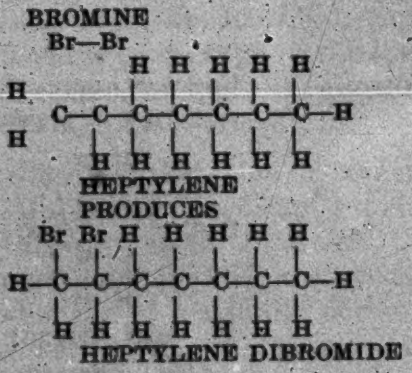
A. On "Sheet G"—which I hand you herewith—

"Sheet 'G", is as follows:

[fol. 138]

BROMINE ADDITION

G



A. (continued). We have the reaction of a bromine molecule, which contains two atoms of bromine, which is designated by its symbol "Br-Br" reacting with heptylene, which was shown on "Sheet E" and also on "Sheet F." The bromine being brought into contact with the heptylene reacts to add to the doubly, united carbon atoms, this addition taking place rapidly but not instantaneously (ordinarily we allow about a 15-minuate period for its completion) and we get as a resulting product, heptylene dibromide, indicated at the bottom of "Sheet G", in which we now have the bromine as a part of this large molecule and in stable form. If we measure the amount of bromine we put in and find the amount of bromine that is left over, that is, has not reacted, we can get by the difference the amount which has reacted to form such a product as heptylene, dibromide.

Q. Do I understand that the bromine does not react to any considerable extent except with the double bonds?

A. That is correct. It reacts in the case of hydrocarbons of unsaturated types. There are cases where it will react with some one of those that are saturated, but these are found in but small amount in the cracked petroleum products.

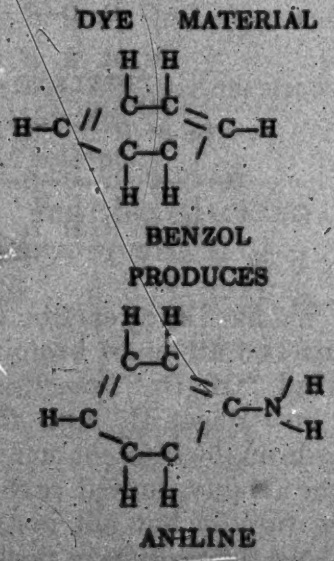
Q. In your testimony of October 12th you stated that benzine or gasolene could not be used for porduction of colors, whereas the benzol and benzine could. Will you please explain why this is true?

A. On "Sheet H", which I hand you herewith—

"Sheet H" is as follows:

[fol. 139]

H



A. (continued). I have indicated the product, benzol, which is the same as benzene, but is quite different from benzine, which last would be perhaps best indicated by the decane and heptylene on "Sheet E". That is, they are the straight chain products in which the carbons are united one after another, whereas, in the case of benzol we have a bringing around and linking of the two ends together to make what we speak of as a closed chain or ring; in the benzol we have a material which, on treatment with nitric acid, and then with iron and hydrochloric acid gives a

product as shown on the bottom of the page, which we know by the name of aniline, and it will be noted, an "N.H.H." group has taken the place of an "H" atom of the benzol. This aniline is the basis of that group of dyes with which we are most familiar, and we cannot, it is obvious, obtain such a product from the gasolene products such as decane or heptylene, because it takes this ring group to be effective from the dye side.

Q. In your testimony of October 12th you stated that the processes of Burton Patents 1,105,961 and 1,167,884 are identical. Do you know of any statement made in the prosecution of either one of these patents that would support your statement?

A. In the file wrapper of Patent No. 1,167,884, paper No. 3, page No. 2, Lines 1 to 9 of the paragraph beginning about [fol. 140] the middle of the page, we find the following submitted by the applicant through his attorney:

"It is respectfully submitted that this is exactly the situation in the patent application; applicant's prior patent referred to in the Office letter of June 4th, 1915, as well as applicant's prior patent 1,105,961, are process patents directed to the production of a definite series of hydrocarbons known as gasoline in one instance, and as paraffin-wax in the other instance. In carrying out both of these processes there is produced an intermediate stage, the product defined by Claims 1 and 2."

The Master: What is the product defined by Claims 1 and 2?

The Witness: Claim 1, "A new article of manufacture; a petroleum oil characterized by the following approximate relation between its gravity and its viscosity, $51x^2 + 106xy - 961x\ 29y^2 - 244y\ 53296 = 0$; where x is the viscosity at 100° F. according to the Saybolt viscosimeter and y the Baume gravity of the oil."

Claim 2 is:

"A new article of manufacture, a petroleum distillate produced by the following process: Distilling an oil having a boiling point of upward of 500° F. at a temperature from about 650° to 850° F. and under a pressure of upward of 3 atmospheres until about 65 per cent. of the oil has been distilled over, drawing off the residue from the

pressure still, distilling the latter under approximately atmospheric pressure and condensing and collecting the distillate."

Q. Referring back to methods of purifying petroleum hydrocarbons, will you please state whether or not to your knowledge the art that you have mentioned in the previous answers or testimony, or other art prior to 1913, disclosed the treatment of gasoline-like material containing a substantial amount of unsaturated bodies, with diluted sulphuric acid of such strength that no substantial carbonization occurs, or the strength is proportionate with respect to the contents of unsaturated bodies to remove a part and leave a part of such unsaturated bodies; and if so, will you please point out where the disclosures occur?

A. Such disclosures do occur.

Redwood, Volume II of his book on Petroleum——

The Master: Published when?

The Witness: Published in 1900.

A. (continued). Mentions the use of sulphuric acid of specific gravity 1.720. This means an acid of between 78 [fol. 141] and 79 per cent. strength. He also suggests the reuse of acids which have been previously used for other distillates, and that would mean the use of an acid whose strength had been decidedly reduced. Such acid and alkaline treatment, he states, creates a loss of from 26 to 30 per cent. of the volume of the oil, but as in the cracking process, he discloses there probably is 40 to 50 per cent. of unsaturated hydrocarbons, we would have left a considerable portion of this unsaturated—of the gasoline-like products carrying unsaturated constituents.

Armstrong and Miller in the Journal of the Chemical Society of London, Volume 49, on page 76 (this is published in 1886) treats the cracked products with "moderately dilute sulphuric acid (two volumes acid, one volume water)" in the refining process.

Then, later, on the same page, Line 20, we have (beginning really with line 18) "It is desirable when the action appears to be at an end to separate the acid from the oil and to treat the latter with strong acid 4:1".

The first acid would be about 75 or 76 per cent. and the second acid would be somewhat stronger.

A third citation which is of interest in this connection is in the Analyst, in an article by Allen, Volume 6, published in 1881, page 179. Here he is studying the relative proportion of unsaturated products in shale oils and in well petroleum oils, and he states that he finds, with "samples of representative commercial products" the following results.

In this connection, it must be borne in mind that at this time the customary scheme of treatment of petroleum products in refining was to treat them with sulphuric acid, and then with water and alkali, and water afresh, sometimes redistilling at the end of the treatment. He finds there that the gasoline from shale is highly unsaturated, as he gives it a bromine number of 67.1, and the gasoline from petroleum is partially unsaturated, having a bromine number of 5.1; the higher boiling portions which we know nowadays as gasoline, but which were then known as shale naphtha and petroleum naphtha, have, respectively, bromine numbers of 94.9 for the shale naptha and for the petroleum naphtha 10.0. This shows that commercial products of satisfactory quality had been made by the treatment with sulphuric acid scheme and still carried considerable amounts of unsaturated hydrocarbons. He also gives the figures for the higher boiling oils, but I presume they are of no interest at the present instant.

[fol. 142] Q. What would be the iodine number corresponding to the bromine number you have read, approximately?

A. The bromine number of 67.1 for the gasoline from shale would correspond to an iodine number of 107.4. The bromine number of 5.1 for the gasoline from petroleum would correspond to an iodine number of 8.2, and the bromine number of shale naphtha, which would be included in the present day gasoline and which is here given as 94.9, would correspond to an iodine number of 151.8, and for the petroleum naphtha, for which a bromine number is given as 10.0, we would have the corresponding iodine number as 16.

Q. Do you know anything in the file wrapper of the Ellis Patent No. 1,318,061 to support your opinion that the product disclosed in Ellis Patent 1,318,060 was known in the art prior to the filing of the applications on which these Ellis patents were granted?

A. In the file wrapper of patent No. 1,318,061, Paper No. 18, Page 2, we have the three claims, 3, 4 and 5, reading as follows:

"Third. As a motor spirit, a gasoline-like material of a complex character and substantially water white in color, containing an amount of unsaturated bodies corresponding to an iodine number of at least 30.

Fourth. As a motor spirit, a gasoline-like material of a complex character and substantially water white color, containing a substantial amount of unsaturated bodies, but being substantially free from resinifying olefines.

Claim 5. As a motor spirit, a gasoline-like material of a complex character and water white color, containing a substantial amount of unsaturated bodies, but being substantially free from olefines, readily forming resinous bodies on exposure to air."

The Master: Were those claims all carried into the patent?

The Witness: They were finally withdrawn.

A. (continued). In paper No. 19, page 1, the Examiner calls attention in a line near the bottom of the page:

"It might be said that a mixture of pure gasoline and of benzol would anticipate the third, fourth and fifth claims."

And on papet No. 20, page 1, the applicant, near the middle of the page, in response to the Office letter which I have just quoted, cancels Claims 3, 4 and 5.

Q. What division number is given in that letter of rejection?

[fol. 143] A. Division No. 31.

Q. What division numbers are given in the file wrapper of the Ellis patent, No. 1,318,060?

A. The division under which this, which is the product patent of Ellis,—is Division 15.

Q. How do the titles of these two applications compare?

A. The division of this one, No. 1,318,060, is for "Improvement in Motor Spirits," which might be said to be a fuel.

Q. And what is the other one, Doctor?

A. The one which is referred to Division 31, "Improvements in Process Making Motor Fuel."

Q. Looking at the file wrapper of the patent No. 1,318,060, do you find any reference to the art cited in the earlier application of patent No. 1,318,061, or any of the arts you have mentioned?

A. I find a reference here by the Examiner to Thorpe's Outlines of Industrial Chemistry, published in 1899 by MacMillan Company, New York, pages 291 to 293, and a statement that it is "old to crack hydrocarbon oils and subsequently to purify them with sulphuric acid" as disclosed in this situation, "and it is believed that the claims read on oils by the processes described by Thorpe; no invention recited in specifying certain properties which such oils properly possess, and the claims are therefore rejected on Thorpe."

Mr. Rauber: I offer in evidence as Petitioner's Exhibit 161 photostatic copies of pages 290 to 293 of Thorpe's Outlines of Industrial Chemistry, 1899 Edition.

The said photostatic copy of pages 290 to 293 of Thorpe's Outline of Industrial Chemistry, so offered, was admitted in evidence, marked Petitioner's Exhibit 161 and the same is herewith returned.

A. (continued). Continuing my answer I would call attention that on paper No. 5, after an argument by the applicant, the Examiner makes a statement:

"Applicant will be required to submit a report of tests by some recognized testing laboratory, showing the difference between iodine absorption of the oils treated according to the reference and those treated according to applicant's process. At the present the claims are rejected on the reference to Thorpe of record."

We have those substantially repeated in Paper No. 7, page 1, the Examiner's total letter reads, "In response to [fol. 144] letter of June 1918, the claims have been reconsidered and are finally rejected on Thorpe of record."

Q. In the pressure stills of the art prior to 1909, what means and methods were used for holding the still gasoline vapors under pressure and for regulating the pressure of the stills?

A. The methods used for holding the liquid which was being cracked under pressure were, in general, either a valve at the outlet of the condenser or a valve between the condenser and the still.

A further scheme which was used, particularly in such cases where it was desired to make the process continuous, was to put a pump to feed the oil into the still, such pump being capable of giving the particular pressure wanted.

A fourth scheme was sometimes used in which, at the start of the process a gas was pumped in the still to give the pressure desired at the beginning, but this would be stopped when the vapors themselves would furnish the pressure needed.

Q. In each case, would you have a valve at some point where the vapors left the still; that is, either at the condenser of the still or some other point?

A. In order to hold the pressure you must have a valve at some point in the line after the vapor left the still, either between the condenser and the still or at the exit of the condenser or at the exit of the tank to which the condensed liquid from the condenser accumulated.

Q. What did the art prior to 1909 teach as to the effect of supplying a pressure release or regulating valve between the still and the condenser, as against placing it at the end of the condenser?

A. Laing, Transactions of the Royal Scottish Society, in 1894, Volume 13, pages 151 to 162, discusses this question, and particularly on pages 158 to 159. He calls attention that if the pressure valve is placed direct on the swan neck from the still, that is, between the still and condenser, the vapors as they escape from the still, rush with irregular force and with a great force at the instant they are emitted through the valve into the condenser. In other words, that, due to the movement through the valve—there would be puffs of vapor passing into the still.

On the other hand, on page 159, he states that if the pressure valve is placed at the end of the condenser coil, the oil under pressure after it has been condensed and removed from the tank at the bottom of the condenser will, [fol. 145] when removed to the air, boil up and effervesce, as an aeriated water; that is, as a carbonated solution would act, and thereby there would be an inconvenient and troublesome escape of volatile gases.

In Laing's time they were not interested in the saving of these very light products which we would now speak of as the lighter portions of gasoline, but in his time they wished kerosene. The gasoline products were useless and hence at that time it was an argument against putting the valve at the end of the condenser; whereas, at the present time it would be an argument in favor of putting the valve at the end of the condenser. There are other citations, many others, where——.

Q. In that instance mentioned by Laing, where you put the valve at the end of the condenser, would there be any question but what the vapors are condensed under pressure?

A. No.

Q. Do you find any disclosure in Dewar & Redwood patent No. 419,931, Petitioner's Exhibit 103, of condensing under pressure?

A. On page 1, Lines 44 to 50 we have this statement:

"Our invention relates to a method of conducting the distillation by suitable apparatus in such manner that we get the benefit of regular vaporization and condensation under high pressure, and that we may at the same time get such an advantage as can be obtained from cracking."

Again, line 61:

"The distillation and condensation being thus conducted under considerable pressure, which can be regulated at will, we obtain from the heavy residue a quantity of more or less light oil suitable for illuminating and other purposes, which cannot be obtained by distillation under atmospheric pressure."

Furthermore, we have in Fig. 1 a drawing accompanying the patent, a valve or cock joining the receiver D'2 to the pipe D'4, showing the same kind of an arrangement in this respect as Laing discussed.

[fol. 146] Q. Have you read and do you understand the disclosures of Adams Patent No. 1,320,354?

A. I have.

Q. From your reading and study of this Adams Patent, No. 1,320,354, what do you understand to be the most characteristic feature of the apparatus described in this Adams Patent?

A. The use of an internal heater. This internal heater is, in this particular case, an electric heater, which is independent of the walls of the retort.

Q. On what do you base your opinion given in the preceding answer?

A. Wait a moment. I beg your pardon. That is not for this patent. I was confused on that.

Q. Here is the patent I refer to.

A. Yes, that is all right—1,320,354—that is all right. This electrical heater——

The Master: Where is the current applied?

The Witness: Right here. This electrical heater is apparently the item on which Adams placed the greatest emphasis, and it is, as I said before, a heater which is independent of the walls of the retort.

Q. On what do you base the opinion given in your preceding answer?

A. For example, the giving of practically four columns, on pages 4 and 5 of the patent, besides many other sentences, and a few paragraphs elsewhere in the patent, devoted exclusively to this kind of an electrical heater.

The Master: The general apparatus of which this heater forms a part, is of the conventional type, the principal novelty being this internal electrical heater?

The Witness: Yes. I wish to correct my testimony I gave a moment ago, of four columns. It is really six columns, pages 3, 4 and 5, instead of four columns.

Q. Do you find any confirmation of the opinion which is given in the file wrapper of the application on which Patent No. 1,320,354 was granted?

A. I would like to have that file wrapper. In paper No. 36, page 2, about the middle of the page, the applicant writes as follows——

Q. Pardon me. What paper was that—what was the title given to it?

A. In paper No. 36—it is a brief before the Commissioner from an appeal from the Examiner in Chief. The applicant states:

"Applicant discloses an apparatus in which he uses an internal electrical heater, and in which, therefore, the

heater is a distinct and separate element from the walls of the container which holds the oil."

Q. What reply did the Commissioner make to this brief?
A. The Commissioner, in pape. No. 37, page 2, states:

"The claims relate to an apparatus for cracking oils. In the brief on this appeal it is said 'The heater is a distinct and separate element from the walls of the retort which hold the oil.' The references disclose no such separate heating element. This is undoubtedly true, but the claims do not bring out this difference."

At the last of the page we have it that the decision of the Examiner in Chief was affirmed.

Q. In the original specification, as filed, as shown in this file wrapper and contents, what did you judge to be the importance of the use of pressure?

[fol. 147] A. I thought I had a memorandum here covering vacuum pressure, as equally important, in the original specification, but I do not now find the words of the specification in which this is.

The Master: Does it stress, or does it not stress the importance of pressure?

The Witness: The vacuum and pressure were equally important. I have that definitely in mind—that in the specification vacuum and pressure were equally important—you can take your choice—and they were equally important.

Q. Did you notice the description——

The Master: Just a minute. Is it your understanding that there is something about the apparatus and the electrical heater that gives an advantage in the availing of pressure and vacuum?

The Witness: Yes, sir, it would be a much more convenient scheme, particularly when working with small units, than an externally heated retort.

The Master: You see, in looking over the application I find that there is nothing in the specification that in any way takes any advantages to be gained by the use of this apparatus, or the economy to be made, in any way, either

in point of time of the operation, or anything of that kind. You think that it would afford some advantages in the matter of time consumed, or availing of pressures?

The Witness: No, not in time consumed, but in convenience in operation, though it would be more expensive to operate.

The Master: In other words, electric current would cost more than the conventional form of heating the chamber?

The Witness: Yes, sir. The electric current scheme is more convenient, but much more expensive in operation.

Q. That was not brought out in the file wrapper, was it?

A. No. I thought it was my opinion that was asked.

The Master: I don't hold you responsible for bringing that out, Mr. Rauber.

Q. Do you remember of any mention of a pressure con- [fol. 148] trol valve in any particular position in the apparatus described in the original specification and drawing?

A. In the original specification and in the drawing there is no pressure valve indicated, either between the condenser and the retort, or after the condenser. In Paper No. 15, page 2, upper part of the page——

Q. What is the nature of that paper?

A. It is a letter to the Commissioner of Patents, signed by the applicant, with the name of counsel attached.

We have this statement:

"In the forms illustrated in Figures 1, 5 and 11, where the condenser is shown in free communication with the converter, the pressure in the converter will, of course, extend throughout the condenser, and, therefore, in order to maintain the pressure it is necessary to have some closure for the system beyond the condenser. Such a closure will be understood by those skilled in the art as existing in the pipe, 179, beyond the point where that pipe is broken away, in Figure 5. And such closure is illustrated in Figure 11 as consisting of a valve, 181, in the liquid discharge outlet."

Q. Do you find in the same paper, any explanation for this late offering, or disclosure of the control valve?

A. Page 13 in the same paper:

"It is submitted, however, that the examiner is wrong in objecting to the new drawing, embodying Figure 11, as including new matter. The Examiner has suggested that valves 181 and 182, and the receptacle X, constitute new matter, because they involve pressure distillation, and should be cancelled. It is submitted that he is wrong in that contention."

"On page 14, now, as shown in original figures 1 and 5, there are no valves or closures of any kind shown between the converter and the condenser, and it is perfectly obvious that the escape of vapors from the system must be prevented, or retarded in some way, in order to operate under well pressure. The applicant, therefore, under well settled practice has the right to show some closure or valve, which will make the device operate in the way that he said it would operate."

"It is respectfully submitted, therefore, that the Examiner should withdraw his objection to the new drawing and the description of it, as well as the objection to these claims which involve the presence of vapor pressure in the system and through the condenser."

"It is submitted that these features were clearly dis- [fol. 148] closed in the case as originally filed, and that applicant has a right to add to the drawing the valve which one skilled in the art would naturally add to the apparatus to carry out the operation as described originally."

Then, in the Office action, given in paper 16, signed by the Examiner, he discusses the use of pressure.

Q. Will you please compare the disclosures of this Adams patent with the disclosures of the art prior to 1909, particularly as to the manner of controlling the pressure and the manner of heating the oil?

A. In Dewar & Redwood, U. S. Patent No. 419,931, of January 21st, 1890, discloses the—just read that question, please?

(The reporter read the question as follows:)

"Q. Will you please compare the disclosures of this Adams patent with the disclosures of the art prior to 1909, particularly as to the manner of controlling the pressure and the manner of heating the oil?"

A. (continued). Continuing the answer on this patent—show the same manner of controlling pressure as is disclosed by Adams—that is, a valve at the outlet of the condenser, or, in this case, the receiver from the condenser. But it does not show the internal heater separate from the walls of the retort.

The Master: In this Adams Patent that you are talking about, is this heater inside of the retort, and the heated body immersed in the contents of the retort, or does the oil pass through the heater?

The Witness: The oil passes around the heater, inside of the container upwards, past the——

The Master: That container being——

The Witness: The pipe.

The Master: That container being the equivalent of the retort?

The Witness: Yes, sir. It could pass between the rods, as well.

The Master: Would you consider the method of heating fluid bodies by immersing in them a heated rod, the injection of steam, or steam heated coils, as all equivalent methods of heating bodies?

The Witness: Not commercially. They would be, perhaps, equivalent in a laboratory. We have trouble, for example, in using high temperature—superheated steam—at such temperatures as we are concerned with in cracking, [fol. 150] due to the action of steam on the steel pipes, and in the case of electrical heating we have no such trouble. The scheme works smoothly enough. The only handicap is the question of the cost of the electrical current.

Continuing my answer to the question of counsel: Laing, in U. S. Patent No. 471,291, of March 22nd, 1892, discloses a retort whose scheme of control is essentially the same as that of Adams, excepting that he puts his valve between the still and the condenser, instead of, as Adams later does, after the condenser.

He does not, however, use an internal electrical heating element, but heats the walls of the retort, instead.

This same scheme is repeated in Laing, U. S. Patent No. 488,767, and we have, in addition, Laing's article in the Transactions of the Royal Scottish Society, which I quoted earlier this morning, in which he discusses the putting of

the valves at the end of the condenser, or between the condenser and the retort. I refer particularly to pages 158 and 159 of the Transactions of this Society of 1894.

In Russian patent, Inchick, Patent No. 4,584, 1890, he describes, again, a retort whose walls are heated, and mentions the use of pressure in carrying it on. This, however, again, is, as in all of the other cases, not a case where the internal heater is separate from the walls of the retort, is used, but, instead, the retort, itself, is heated.

Redwood's Treatise on Petroleum, Volume I, pages 317 to 322, of 1896, and particularly page 321, shows, again, a control of pressure which is essentially the same as that finally used by Adams, but, again, there is the distinction of the Redwood disclosure not carrying an internal heater separate from the walls of the retort. In the Redwood disclosure the walls of the retort, itself, are heated.

In Schucow & Gravrilow, Russian Patent No. 4,782, also known as No. 175, of 1891, uses the same scheme of controlling pressure, excepting that the valve is placed between the still and the condenser, instead of after the condenser.

Again, it is the walls of the retort, however, which are heated, and there is no application of an internal heater, free from the walls of the retort.

In Kittle, French Patent No. 417,532, of 1910, we have——

Q. That is too late.

A. My attention is called to the fact that this is too late a citation, so that I will not go into it.

[fol. 151] Pielsticker, British Patent No. 1,308, of 1891, uses, again, the same scheme of a valve to control the pressure, and in this case he places it after the retort, but before the condenser. He does not, however, use an internally separate heater—that is, separate from the walls of the retort.

The same is true in the corresponding Pielsticker U. S. Patent No. 477,153, of June 14th, 1892. This is essentially the same as the British patent.

The Master: You do not find in the prior art any device for internally heating—is that true?

The Witness: Not an internal separate heater.

Testelin and Renard, British Patent No. 16,881, of 1908, again cracks under pressure and controls the pressure by

means of a valve between the retort and the condenser. In this particular case the condenser being preceded by a separation vessel somewhat of still type, and it is between the retort and this vessel, "B," of the figure, where the valve is.

Again, it is a case where there is not a separate internal heater used.

Q. Please state whether or not, to your knowledge, the art that you have mentioned, or other art prior to 1909, contained any disclosure of an apparatus comprising the source of oil, a receptacle connected therewith, means for maintaining oil under pressure in said receptacle, and a heater adapted to be maintained at a cracking temperature, considering the heater to be either an internal electric type or heating through the walls of the retort.

A. Several of these citations that I have given in answer to your previous question give such disclosures.

For example, the Dewar & Redwood United States patent of January 21st, 1920, the Laing disclosure, the Russian patent to Schuchow-Gavrilow, and the two Peilstaker patents, and the Testilin and Renard, all disclose this.

Mr. Wiles: Mr. Rauber, was that a claim you were reading to the witness?

Mr. Rauber: It contained a portion, at least, of Claim 23 of the Adams' patent. It was not exactly the claim, as I recall.

Q. Do any of this art that you have mentioned also disclose the pump for forcing oil from said pressure into the retort and means for withdrawing and condensing under pressure vapors evolved from said containing receptacles?

A. They do.

[fol. 152] Q. Will you please point out wherein these features are disclosed?

—. Dewar & Redwood's, U. S. patent No. 419,913 of January 21st, 1890; similarly Redwood's Petroleum, Volume I of 1896. I believe that is all.

Q. In your opinion, would the pumping means disclosed in these various references be capable of continuously forcing oil into the still?

A. Yes.

Q. Have you read and do you understand the disclosures of Adams' patent No. 1,327,263?

A. I have and I understand the essentials.

Q. From your reading of the specifications of Adams' patent No. 1,327,263 what do you consider to be the most characteristic of the process described in this patent?

A. The intense incandescent temperature used in the cracking; temperature in the range of 1,750, even 2,000° Fahrenheit.

Q. Do you find anything in the file wrapper of this Adams' patent, No. 1,327,363 to support your opinion?

A. In the original specification as given on page 3, lines 24 to 29, I read as follows:

"This, I accomplish by subjecting the oil or mixture of oils to the powerful influence of a properly applied external decomposing temperature, which will range in intensity from a visible or bright cherry red to a full white heat, according to the character of the particular oil undergoing the conversion treatment."

On the following page, page 4, 9 line, it reads—well, I will read lines 7, 8 and 9:

"Figure 2 is a sectional elevation showing one of the many possible forms of converter which may be employed * * * externally subjecting oil into an incandescent temperature by the application of an intense heat."

Continuing on the specification, page 9, lines 8 to 12 inclusive:

"It is sufficient to state, however, that this chamber is of such a character that the central and greater part of it may be maintained at a high temperature ranging from a bright cherry red to a full white heat by the application of external heat to it while containing oil."

Page 10, line 1, speaking of the oil, states it may come, "into more or less direct contact with the superheated walls of the cracking chamber, 12".

Line 16 he speaks of "the superheated walls of the chamber for the purpose of cracking."

Page 11, line 6, he speaks of the incandescent heat, and line 26, "the maintenance of intense heat within the retort."

Line 28 he speaks of heating the walls of the cracking chamber to "incandescence while containing oil."

And line 30 he speaks of the oil which is in the immediate vicinity "of internal incandescent walls of the chamber."

Page 13, line 28, he again speaks of the oil "comes in direct contact with the incandescent walls."

On page 14, lines 5 and 6, "these mixed vapors are evolved very rapidly owing to the incandescent temperature of the cracking chamber."

[fol. 153] Again, in paper No. 3, which is from the applicant to the Examiner, page No. 2——

Q. When was that filed?
A. This paper?
Q. Yes.
A. Filed May 2nd, 1912.

We have this statement, lines 2 to 9, in differentiation from another citation:

"In his spiral or serpentine tube supported over a pipe wherein he maintains a heat from 700° F. to 1000° F., he had no idea of cracking kerosene or transforming other light Baume gravity oils into benzines and gasoline, for it requires a heat beginning at 1,750° F. to bring about any appreciable cracking of the petroleum oil molecule and it is not economically or commercially practicable to bring about such transformation under a heat of 2000° F."

Again, in the supplementary specifications which Adams filed at this same time, on page 3, the fifth paragraph, we find as follows:

"This, I accomplish by subjecting the oil or mixture of oils to the powerful influence of a properly applied external decomposing temperature, which will range in intensity from a visible or bright cherry red to a full white heat, according to the character of the particular oil underg-ing the conversion treatment."

I believe that is all I find on that in the file wrapper.

Q. About what temperature in Fahrenheit would a temperature of visible or bright cherry red to a full white heat be, approximately?

A. I would say from about 1150 Fahrenheit to 1850 would be as low as I would count as a full white heat.

Q. Do you find any mention of pressure in the original specification of this Adams' file wrapper?

A. Yes, but always—I think always or at least nearly always, in connection with vacuum.

The Master: In connection with what?

The Witness: With vacuum.

A. (continued). For example, page 4, line 26, "Notwithstanding the partial vacuum or compression it may be maintained over the surface of the oil in the converter."

Page 7, lines 9 to 12, "when under atmospheric pressure or a more or less complete vacuum or compression for the purpose of bringing about a conversion of such oil."

[fol. 154] Lines 29 and 30——

Mr. Cooper: Same page?

The Witness: Of the specification, page 15, it should be; thank you.

A. (continued). "The upper part of this reservoir, 32, is connected with a suitable suction or vacuum apparatus, F, by means of pipe 51."

And on page 16, first line:

"Such vacuum or compression apparatus may comprise"—and then discusses it.

Lines 2 and 3 of page 16, the pipe 39 connected with "a vacuum or compression tank."

I think I ought to read more of page 16.

Beginning at line 1:

"Such vacuum compression apparatus may comprise a convertible pump, 52, connected by a pipe, 39, with a vacuum or compression tank, 33, provided with gauges, 37, for the purpose of showing the degree of the vacuum or compression. This convertible pump, 52, is provided with an in-take for exhaust pipe 38, and is conveniently operated in any desirable manner by power.

The utility of the vacuum apparatus when drawing certain oils in conjunction with other features of my invention, is very great, for thereby I am enabled to reduce liability of burning to a minimum; and, furthermore, mate-

rially promote uniformity and certainty in the operation of the entire apparatus. Thus, because of the vacuum it is not necessary to depend upon gravity for the flow of the oil from the main supply tank, 1, to the converter, B, nor is it necessary to provide a force pump apparatus operating from the main supply tank to remove the original oil, because of the more or less complete vacuum in the converter, the oil will flow from the supply tank, being sucked into the converter, so to speak, and the rate of flow is under easy control by means of hand valve, 10, in pipe, 9. Moreover, as long as the vapors in dome, 13, of the converter, B, are maintained at a very low pressure, there is very little chance of an explosion, even though some air or other wrecking substance should become mixed with the oil vapors. When the entire apparatus is working under a more or less vacuum, it will be perceived that the condensed oil will not gravitate or flow out of the reservoir, 32, by apparatus, "E, and therefore it must be withdrawn through valve 40, by suction pump."

[fol. 155] Page 17, 9th line, beginning with that line:

"Furthermore, the compression in connection with the treatment of certain oils will promote uniformity and certainty in the satisfactory operation of the apparatus, and therefore the compression, as well as the vacuum, in addition to normal atmospheric pressure at certain times, become important features in this process."

These are all that I find in the specifications.

Q. Do you find in the file wrapper of this Adams' patent No. 1,327,363, any explanation of when pressure is used and when vacuum is used?

A. Yes, I do.

Q. Where do you find such explanation?

A. In paper No. 3, the substitute specification, which Adams wished to substitute for the original ones, page 16, the latter half of the page we find as follows:

"Furthermore, the compression in connection with the treatment of certain oils will promote uniformity and certainty in the satisfactory operation of the apparatus, and therefore, the compression as well as the vacuum, in addition to normal atmospheric pressure, at certain times be-

come important features in this process. Thus, from practical experience it has been found that a slight pressure maintained over a body of oil contained in the converter when above 50° Baume, retards somewhat the volatilization of the lighter vapors in a desirable manner and hinders a free and uniform flow of products therefrom. On the other hand, a slight vacuum maintained over a body of of oil contained within the converter when below 50° Baume accelerates the volatization of the heavier vapor thereby rendering a more constant and uniform flow of product and a greater yield in a given time."

In other words Adams states that in cracking oils with a density corresponding to fifty degrees Baume, you have the dividing line; and when cracking oils above this density, or above numerically 50° Baume, that is such as would correspond at the present day to, perhaps, a light boiling kerosene, we could use pressure; whereas, in cracking oils with a density less than 50° Baume, such as a gas oil or a crude oil, we would use vacuum.

Q. Do you find anything in the file wrapper that would support the statement that he cracks oils lighter than 50° Baume?

[fol. 156] A. Yes, I find in paper No. 9, substitute specifications, page 8, lines 19 to 21——

Q. Paper No. what?

A. Paper No. 9, in the substitute specifications, page 8, lines 9 to 21, reads as follows:

"I may here state that when operating upon certain classes of oil, that is, the more volatile oils and spirits such as kerosene and benzine, it is highly desirable to localize the application of the external heat so as to prevent the spread—"

and so on.

In other words, here he mentions the cracking and using as raw material kerosene and benzine.

Q. In paper No. 3 of the substitute specifications, page 9, lines 12, do you find any mention of benzine?

A. Yes, I read as follows from page 9 of paper No. 3, beginning at line 10:

"I may state that when operating upon certain classes of oils, that is, the more volatile oils and spirits, such as petroleum, kerosene and benzine," etc.

Q. Do you find in the file wrapper of Adams' patent No. 1,327,263 any comparison with or distribution from the cracking of oils by circulating them through tubes to a cracking temperature?

A. Adams here states——

The Master: What paper?

The Witness: In paper No. 5, page 4.

Q. What is the paper No. 5?

A. Paper No. 5 is a letter of Adams to the Commissioner of patents received June 19th, 1913, and on page 4 of this communication to the Commissioner, lines 9 to 14:

"The applicant regrets that the Examiner took his reference to Benton 'scornfully' as no such attitude was meant other than to show the impractibility of trying to crack oils in tubes, coils or other small pipes and passages without some means of removing the carbon, the natural residue from a real cracking and oil converting process."

Q. In the specification of the Adams' patent, in the file wrapper of patent No. 1,327,263, do you find any description of a valve—pressure release valve, located at the outlet of the condenser or anything that would indicate that that feature was characteristic of Adams and Benton?

A. I do not.

The Master: You mean of the absence of such a release valve was characteristic of the invention?

[fol. 157] The Witness: No.

The Master (continued): Or the presence of it was characteristic?

The Witness: Neither the presence or absence of it was characteristic. The characteristic idea was the question of the intense temperature and such a valve is not indicated.

The Master: That indicates that he preferred the absence of the valve?

The Witness: That would be my interpretation.

Q. On page 4, lines 9 to 14 of the patent as issued, do you find any statement as to the materials to be used in constructing the retort?

A. I do. It states: "The oil containing cracking chamber 12, may be constructed of various heat enduring metals, alloys, carbons, graphites, graphite carbon and other materials known to withstand a constant and varying temperature of high intensity."

Q. Would a retort constructed of carbon graphite or graphitic carbon be capable of withstanding a high pressure in your opinion?

A. It would not.

Q. Will you please compare the process of this Adams' patent No. 1,327,263, with the Art, prior to 1911?

A. The essential part of this process of Adams', as I understand it, is the heating to incandescence in a pipe-like retort through which the oil is rapidly moving under pressure and condensing under pressure. I may add that the patent is in form of a process patent but it has characteristics of a process patent.

Q. Of a which?

A. Of a process. It has the appearance, to me at least.

The references of Dewar & Redwood, which I have cited in connection with the previous patent of Adams under discussion, applies also to this one, excepting that we do not have, apparently, so high a temperature used, though the exact temperatures in the Dewar-Redwood are not given. However, the retort and the furnace are such as would imply heating to ordinary temperature instead of to this incandescent condition. With that exception, it is essentially a description of the same process.

Laing transactions of the Royal Scottish Society, Volume 13 of 1894, pages 151 to 162 also describes such a proc- [fol. 158] ess but does not heat to such an intense temperature, and we have here, I may add, the term "pipe-like," as sometimes used in the Adams' patent, not strictly applying in that the pipe in that case is of fairly good-sized diameter and not a narrow pipe.

Mr. Cooper: In Laing, it is a good sized pipe, is it not?

The Witness: Yes.

The Redwood's Petroleum, First Edition, 1898, Volume I, gives essentially the same disclosures as the Dewar & Redwood United State Patent, which I mentioned earlier.

Lang United States Patent 954,571, of April 12th, 1910,

describes cracking in such a pipe-line structure, and is essentially the same process, though the temperature to which the product is heated is not given definitely, as I recall it.

Pielsticker, British Patent No. 1,308, of 1891, describes essentially the same process, excepting that the condensation is not under pressure.

The same is true of the Schcow & Grævilow Russian Patent No. 4782, the same being known, also, as No. 175, of 1891—that is, we have here a cracking in a pipe-like structure, but not condensation under pressure.

Clercq, German Patent No. 166,723, of 1906, describes a coal tar distilling apparatus, which he states can be used not only for tar, but for other oils, and——

Q. Does he show a circulating coil?

A. Yes, sir.

Q. How does that compare with the statement of Adams in regard to circulating coils?

A. It is contrary. He says the circulating coils cannot be worked—cannot be used.

Mr. Cooper: Who says that?

The Witness: Adams, in the file wrapper—but this is one without pressure condensation.

Q. Will you please state whether or not, to your knowledge, any of the patents that you have mentioned, or other art, prior to 1911, disclosed a process of converting oil, which consisted of subjecting the oil to a cracking temperature under pressure, in a closed chamber, supplying oil to said chamber during the cracking operation, to maintain a body therein, and condensing the evolved vapors from the cracked, or converted oil, by passing said vapors through connections to a condenser, the connection through and to the condenser being in open communication, so as to insure a substantially uniform pressure from the heater to the condenser?

A. Yes, sir, there are such prior art, such as Dewar & Redwood, Laing, Redwood's Petroleum, and the Lang citation.

The Master: Do you consider those to be continuous processes?

The Witness: All of them, I believe—yes, they are all continuous processes.

Q. Do any of the various patents that you have referred to in the prior art, disclose a continuous supply of oil to the cracking chamber?

[fol. 159] A. Yes. The Dewar & Redwood, U. S. Patent No. 419,931, of 1890; the Redwood's Treatise on Petroleum, 1896; the Laing reference, in the Royal Scottish Society, shows an apparatus capable of being operated continuously, but I don't recall that it is so stated in the text.

The Witness: I am not through. The Laing, United States Patent No. 488,767, which is the same man Laing, referred to in the citation just preceding, states that a still may be fed continuously—on page 2, line 29.

The Master: And the still described is the same as described in the proceedings of the Scottish Society?

The Witness: That is correct.

Pielsticker, British Patent No. 1,308, of 1891, is a continuous process.

The same is true of the corresponding United States Patent of Pielsticker, No. 477,153, of June 14th, 1892.

Also of Schucow & Gravrilow Russian Patent No. 4,782, of 1891—that is also a continuous operating process.

I guess that is all.

Q. In the prior art that you have just mentioned, did you find any instances in which the pressure in the cracking chamber was maintained solely by the vapors generated in the chamber? That is, without the addition of inert gases?

A. Yes.

Q. Will you please mention them?

A. The only one of those which I have mentioned, in which the pressure was obtained by any other gas, was that of Dewar & Redwood, and the Redwood citations of 1890, and Redwood's Petroleum, of 1896, where at the beginning of the operation an inert gas was present.

In one of the others I think there is steam used in the operation, but the remaining ones are without the use of steam. I can confirm that on the steam, if it is desirable.

Q. Have you read Burton Patent No. 1,049,667, and do you understand the disclosures in said patent?

A. I have read it and I understand its essentials.

Q. What do you consider to be the most characteristic feature of the process described in the Burton Patent No. 1,049,667?

A. The production by this cracking process, according to this patent, of a gasoline-like product, consisting essentially of saturated hydrocarbons of paraffin series.

The Master: That you consider to be the essential characteristic and the invention of the patent?

The Witness: Yes, sir.

Q. Please state whether or not you find in the art, prior to 1912, a disclosure of a method of treating the liquid portions of the paraffin series of petroleum distillation, having a boiling point of 500° F., to obtain therefrom low boiling point products of the same series which consist in distilling, at a temperature from about 650 to abont 850 degrees Fahrenheit, the volatile constituents of said liquid, con- [fol. 160] ducting off and condensing said constituents and maintaining a pressure from about four to about five atmospheres on said liquid, all vapors, throughout their course, to and while undergoing condensation or of such a process in which the gases accumulating from the processes, were released from time to time?

A. I find several citations, or several statements in the prior literature, covering such a method. These are Dewar & Redwood's patent No. 491,931, of 1890, except that they do not state the exact pressure used. They do, however, state that they are using a high pressure and heavily loaded valve, and regulate the pressure by it.

The same apparatus and the same disclosures is essentially made in Redwood's Treatise on Petroleum, Volume I, of 1890, pages 317 to 322.

We have, also, with the exception of condensing under pressure, the same process described by Laing, in his United States Patent No. 471,291, of 1892, but, as I said, Laing does not condense under pressure, as Burton does.

Similarly in Laing, United States Patent No. 488,767, of 1892, we have essentially this same process, excepting that a less pressure is used, and there is no disclosure of condensing under pressure.

In an article by this same Laing in the Tranactions of the Royal Scottish Society of 1894, pages 151 to 161, we

have a discussion of the process, as well as a discussion of pressure condensation. For example, on page 159, is this—if we would include the method given on page 159, with his apparatus sketched and described,—and use, thereby, pressure condensation, we would have a complete disclosure, though the exact pressure is not given. He prefers, apparently, to use a smaller pressure.

Lang, United State Patent No. 954,575, of April 12th, 1910, describes essentially the same process, excepting that he does not definitely state the decreased pressure, nor the decrease of temperature used in the cracking. We can, however, judge, somewhat, of the pressure to be used, from the type of valve, 47, indicated in his sketch, which indicates that it is not a pressure of approximately atmospheric pressure.

I believe that is all.

Q. In the file wrapper of the Burton Patent, No. 1,049,667, there is present a paper, No. 4, an affidavit by R. E. Humphreys—have you read and do you understand that affidavit?

A. I have, and I do.

Q. In that affidavit a process is compared with the Burton process. Will you please compare that comparison of process with the Dewar & Redwood process?

[fol. 161] The Witness: In comparing the two processes under discussion, Humphreys studies the products made by the respective processes, and states as follows:

"Affiant says that to make the said tests he took the gasoline product of distillation of the heavy residues referred to, obtained without pressure, and with the vapor superheated to between 800 and 900° F., and the same quantity of gasoline produced according to the aforesaid process, namely, by distillation of the same residues, under high pressure, and with the vapors superheated by the increase of pressure. We mixed our gasoline product separately with concentrated sulphuric acid, of 95 per cent. strength, in proportions of about two parts of acid to one part of naphtha, which mixture was thoroughly shaken up for about half an hour and was then allowed to stand for a period of about five hours. Thereupon the acid was with-

drawn and fresh acid was added to the residual naphtha, the mixture being again shaken for half an hour and again allowed to rest for a period of about five hours. These operations of withdrawing acids and adding fresh acid, shaking and resting, were repeated as long as any portion of the naphtha was shown to be taken up by the acid. When that condition arrived, and after the final resting of the mixtures, the paraffin series was removed from each container, and separately measured. The results obtained showed, in the case of the cracked distillate,—meaning that produced with the treatment without pressure, but with the vapor superheated, 49.4 per cent. of the cracked, or unsaturated hydrocarbons, had been removed by the action of [fol. 162] the acid, in the case of the pressure distillate, and that resulting from the process of the aforesaid application, 20.2 per cent. only of cracked unsaturated petroleum had been removed by the action of the acid."

Q. Now, pardon me—as I understand it, two processes were used to obtain the products used for comparison?

A. That is correct.

Q. How did these processes compare with Dewar & Redwood?

A. The process of heating under pressure would be the process corresponding to Dewar & Redwood. The process of heating without pressure would be the process corresponding to the old process worked at Newark, New Jersey, which I mentioned in my first testimony.

Q. Would it correspond with high temperature vapor cracking?

A. In part.

Mr. Clark: Of course, it is understood that this is merely what Humphreys stated in his affidavit, and it doesn't go into the record as actual testimony as to what was done.

Mr. Rauber: It is merely a report made by Humphreys.

The Master: Which was merely the representations made by the applicant. Whatever Humphreys said was a representation made to the Office by the applicant for a patent.

Q. In the operation of a pressure still cracking process, does the hydrocarbon oil that remains in the still undergo any change?

A. Yes.

Q. That is, the hydrocarbon oil remaining, is it different from that originally put into the still?

A. Yes.

Q. How do these pressure still residues, compared with the chemical composition in structure from those obtained from straight run distillation,

A. They are much more unsaturated than those obtained from straight run distillation.

Q. Have you read and do you understand the disclosures of Burton Patent No. 1,105,961?

A. I have.

Q. How does this disclosure on this patent compare with that of Burton Patent No. 1,049,667?

A. It covers the distillation of the residue from the Patent No. 1,049,667 and the use of the product obtained as a raw material for a second pressure cracking distillation. In other words, he uses the residue left from the process described in the patent No. 1,049,667 to operate upon in the process described in No. 1,105,961.

Q. Will you state whether or not you know of any disclosure in the prior art in which pressure still residues are re-run, or other residues of other cracking processes are re-run?

A. Barbet, French patent, No. 380,282 of October 4th, 1907, describes an apparatus, but incidentally, he describes the operation of the apparatus and states that the residue from the first cracking process may be re-run. He does not, however, distill to free it from suspended carbon as [fol. 163] an intermediate step, as does Burton; nor does he use pressure in his original process or later steps.

Noad, United States patent, 971,468 of September 27th, 1910, states that the residue, line 60:

"The residue from the rectifying still and any heavy products that may have been condensed and not rectified may be returned to the re-actions chamber for re-treatment."

Noad does not use pressure nor is an intermediate distillation recommended.

In his British patent, the Noad British patent No. 13,675 of 1908, "The heavy products which have once been dis-

tilled and then condensed but not rectified; also the residue may be returned into the process for re-treatment."

It will be noted that in this case there the heavy products were distilled at atmospheric pressure and returned into the process for retreatment.

He does not, however, use pressure at any step of his work.

Testelin and Repard, British patent 16,881 of 1908, cracks under pressure of five atmospheres, which would be approximately seventy-five pounds, and then re-works the heavy portions anew through the cracking process.

O. G. Lobin, in Zeitschrift Fur Angewandte Chemie for 1904, page 546 describes a process operating on Russian oils:

"The product is first fractionally distilled and the product boiling 200° is again subjected to decomposition under pressure."

This would be a distillation of a product which had been once distilled, though not changed in vessels at the stage of removing gasoline and using residue.

Engler, Beruichte der Deutchen Chemschen Gesellshaft, Volume 21 of 1888, pages 1816 to 1827, distills fish oil at a pressure of ten atmospheres, and in some cases, down to four atmospheres and then redistills a part of the product under pressure. It is to be noted that none of these give the removal of suspended carbon as an intermediate step, as does Burton; however, this second cracking distillation of the product without the carbon would be the same, so far as the major amounts of constituents, to distill the product in the presence of the carbon.

Q. In the French patent to Barbet, No. 322,265, Petitioner's Exhibit No. 136, do you know of any reference to the pressure used, or whether pressure was used in the process?

A. He uses or he mentions the use of a pressure of five [fol. 164] to six atmospheres, which would be from 75 to 90 pounds per square inch.

Q. What disposition does Barbet in this patent make of the residue found in his cracking still, or, as he calls them "Black pots"? Where do these pressure residues go?

A. The pressure residues are passed into the column at the point 3 of Fig. 1 and there their pressure is released in part and then distilled over through the condenser R, condensed there and passed into the distilling tower, H, and down into the second still, M, from which they pass back by means of a line and pump to the original tar still, P——

The Master: Is that not precisely Burton?

The Witness: Exactly.

Q. In going into this fractionating column would the heavy residues be relieved or denuded of its volatile constituents or other constituents?

A. Yes.

Q. Would these constituents find their way back into the pressure still?

A. No, they would be collected in the receivers and taken out and sold.

Q. Does any of it——

A. (continued). When I speak of the "volatile constituents" I mean of the light volatile; the heavy volatile may pass through this process.

Q. Into the pressure still?

A. Into the pressure still.

Q. Have you read and do you understand the disclosures of Clark patent No. 1,410,797?

A. I have read and I understand it.

Q. How did the process described in this patent compare with the disclosures of Burton patent No. 1,105,961?

A. Clark is primarily concerned with the plurality of the still, whereas, Burton, with the single still.

Q. In the Clark patent, what disposition is made of the residue in the pressure still?

A. The residue from the original cracking still is withdrawn and the pressure released whereby the lighter fractions distill off, and then the lighter fractions of this residue are returned to the oil body for further cracking.

Q. How does this process compare with the process of the French patent to Barbet, No. 322,265 in regard particularly to the treatment of the pressure residues?

A. It is essentially the same. This is also described in [fol. 165] United States patent—corresponding United

States patent No. 836,732 to Barbet of November 27th, 1906.

Q. To your knowledge, did the art prior to 1909 disclose a step in the art of pressure distillation of petroleum oil which consists of maintaining a considerable body of said oil under cracking conditions of temperature and pressure continuously withdrawing oil from said body and releasing the pressure from the withdrawn oil while the latter oil is in a heated condition whereby the lighter fractions would distill off, collecting said lighter fractions and returning them to the oil body for further cracking therein?

A. Yes.

For example, in the two citations which I have mentioned in answer to the last question.

Q. What citations in particular?

A. Those are the Barbet patents; French patent No. 322,265 and United States patent No. 836,732.

The Master: Is this not substantially what Burton does?

The Witness: Pretty much. There is plurality here which is not in Burton's.

Q. That has nothing to do with the patent?

A. How is that?

Q. You are confusing the patent, that patent with another Clark patent, I believe. This one relates to the treatment of pressure residues?

A. Yes. Well, this one does discuss the plurality in some of the other portions of it, but it primarily—perhaps one of the important differences is that Clark states his pressure distillate out from his still and allows it to exaporate spontaneously from the heat that is within it; whereas, Burton transfers it, apparently, by preferred procedure to an atmospheric still and heats it separately; heats it to completeness, to dryness, distilling off all he can; whereas Clark does not and could not distill to dryness by means of the heat that was in the residue. The next step would be the same, it is returned back——

The Master: The residium upon which Burton performs his second step, might it be called tar?

The Witness: Yes, it would normally be called tar in a plant. The common name for that is "pressure tar."

[fol. 166] Q. In your testimony of yesterday, you stated that retorts made of carbon, graphite and graphitic carbon described among others on page 4 of Adams' patent No. 1,327,263 would not withstand a high pressure. Will you state about how high a pressure retorts made of these materials would stand?

A. Graphite is a quite porous material. I remember particularly experiments which I carried out some fifteen or twenty years ago in which I attempted to use graphite vessels under a vacuum and found that I could not hold a vacuum with them. Also, their porosity is readily shown by the present-day practice of impregnating them with naphthelene or bakelite, or other material in order to prevent gases passing in and flaking off the graphite when it is used as an electrode in the manufacture of gaseous materials by electrolysis, for example, such as chlorine and caustic soda, the chlorine coming off from the graphite electrode.

Such material will readily absorb, say, up to twenty per cent of the solvent, and can be passed through our present-day graphite—artificial graphite materials. So that it is to be expected that it would be difficult to hold a pressure of even five or ten pounds in such vessels and higher pressure practically impossible.

Q. In some of your former testimony you said that in a cracking distillation some of the material being distilled would come over with the vapors. Do you know of any way in which such material is returned to the still?

A. In ordinary distillation, using a simple type of still, we return a part of this by air cooling on the top of the still. Where the capacities are larger and air cooling is insufficient, we use artificial cooling of the vapors, so arranged that the part of the vapors which were cooled and condensed to a liquid run back into the still. In general chemical technology this is called the dephlegamator, but in the petroleum industry it is commonly called a run-back; in some other industries it is also spoken of as a run-back. It amounts to a partial condensation of the vapors, the final condensation taking place in the final condenser of the apparatus.

[fol. 167] The Master: Why "dephlegamator"?

The Witness: I do not know the origin of the word.

Mr. Rauber: I think I can tell you: In distilling alcohols they had what they called a phegm and the dephlegamator was to take up the phegm.

The Master: Well, I suppose the oils coming over in the distilling process might be called more or less phlegmatic?

The Witness: The heavy ones at least.

The Master: And that this dephelegamator was that part of the apparatus where there was a separation of the heavier and the lighter oils; is that not true?

The Witness: That is correct. If we have exact separations to make, that is, separations of only a few degrees difference of boiling point, then we combine this dephlegamator and distill into the condenser with, in addition, a distilling column of some sort which makes the operation still more exact, and we may run back as much as five volumes for every one volume that is condensed in the final condenser. In other words, the dephlegamator would do four-fifths of the condensation and the final condenser only one-fifth, but that one-fifth would be a quite pure product and very——

Q. When you speak of partial condensation in this run-back or dephelegamator, do you mean that you condense a part of all of your constituents or merely the heavy ones?

A. I mean that you would condense essentially the heavy constituents and the light constituents would be left to go on as vapors to the final condenser; the dephlegamator or run-back taking back the heavy constituents as its function and returning them to the still.

Q. How do they obtain this selected condensation?

A. This selected condensation is obtained by keeping the dephlegamator at a particular temperature. In other words, a dephelegamator will not ordinarily use a very cold cooling agent but instead a warm or even hot cooling agent, but still at a temperature slightly below the boiling point of the constituents which you wish to return to the still.

Q. Do you recognize the presence of such a run-back in the disclosures of Adams' patent, No. 1,320,354?

A. I do.

Q. What elements comprise this run-back?

A. It is best shown on Fig. 2 accompanying this patent, in the elements, Nos. 44, 54, 42, and the pipes leading

from this condensation portion 24, and 34. The cooling [fol. 168] in this case is apparently by air only. It is an air-cooled run-back and the effective portion is primarily the portion above the level of the bottom of the pipe, 47, up to the top of the pipe, 44.

Q. Will you please state whether or not to your knowledge the air prior to 1911 disclosed the use of such or similar runbacks?

A. It did.

The Master: What is the number of that patent you are talking about?

The Witness: It is No. 1,327,263.

Counsel calls my attention that the patent number which should have been given is No. 1,320,354. In this patent the runback is shown best on Fig. 2 in the particulars indicated by the Nos. 123, 134, 124 and 126.

The Master: No, it is 122, 123; you made a mistake there. No. 134 is a valve.

The Witness: Yes, thank you. 124 and 126, and that part condensed—change my reply.

The Master: It includes the whole chain there.

The Witness: It is better shown on Fig. 1.

The Master (continued). Of 124, 129, 128 and 132.

The Witness: But it is complicated by these numbers, 143—it is better shown on Fig. 1, the previous figure where it includes the parts—primarily the parts 113, 115 up to the pop valve 121 and the parts there condensed runs back down the pipe 116, through the valve 118 and the pipe 119, through the retort pipe which is the electrically heated retort.

The Master: See what the whole retort number is there; that is lettered A, is it not?

The Witness: Yes, letter A.

Q. Please state whether you find any such apparatus in the art prior to 1909.

A. We have runbacks not of this exact type, used in early times. The earliest would be that of any still with an exposed air-cooled top, and we have as those which are of particular interest in the petroleum industry. Aisinman in Samlung Chemisch-Technischer Vortrage of 1900, Vol. 5, and in particular the work as shown on Fig. 3 in which the dephlegamator or runback is indicated as having a diame-

ter of 500 to 600 centimeters—it should be millimeters, it is a misprint in the original—in diameter and 1500 millimeters high; that would be about two feet in diameter and nearly six feet high.

[fol. 169] Fig. 4 shows such a dephlegamator by the letter "C" with the return indicated by the faint letter "b" and in Fig. 5 we have another sketch showing again the same dephlegamator, and in connection with Fig. 7 it mentions, on page 196 of the original German, the possible use of a dephlegamator with that type of still as well. These are all atmospheric pressure stills which were in use of about that date for cracking purposes.

We have in Pielsticker, British Patent No. 1,308 of 1891, such dephlegamators indicated, for example, in Fig. 3 of the sketches, such an air-cooled dephlegamator is indicated in detail. This one is operating under pressure.

In Pielsticker, United States Patent No. 477,153, of June 14, 1892, we have again such a dephlegamator working under pressure indicated in Fig. 5. This, again, is an air-cooled one.

I should have stated earlier that the dephlegamator first mentioned in the citation from Aisinman is a double-walled one, which apparently was cooled by a cooling liquid instead of air. So that we have both air-cooled and liquid-cooled in this early art.

The citation which I have given before, the Dewer & Redwood United States Patent No. 419,931, January 21, 1890, shows a similar runback in the runback labelled C^2. on Fig. 1. This is an air-cooled dephlegamator working under considerable pressure. The same type of cooler is also shown in the Treatise by Redwood on Petroleum, Vol. 1, page 321, Fig. 100, and is there also designated as C^2. It is designated by a name which is sometimes used, particularly in England, for such rephlegamators or runbacks, that is the name Stillhead.

I believe that meets the important citations I have.

Q. Please state whether or not, to your knowledge, the art that you have just mentioned, or other art prior to 1909, disclosed a source of oil—an apparatus comprising a source of oil, a receptacle connected therewith and a heater combined with the receptacle adapted to be maintained at a cracking temperature in contact with the oil

therein; an outlet for the oily vapors evolved by the action of said heater; a receptacle connected with such an outlet and adapted to collect portions of the oily liquid carried by said vapors; means for returning said collected liquid to the action of said heater, and means for condensing the residual vapors, no pressure being specified.

[fol. 170] A. The Dewar & Redwood United States Patent No. 419,931, described such an operation, but for using it under pressure. Similarly, Redwood's Petroleum, Vol. 1 of 1896, page 321 describes this same process but again is using the scheme under pressure.

Aisinman in Samlung Chemischer-Technischer Vortrage, Vol. 5 of 1900 describes such apparatus but uses it without pressure. This is in particular on pages 196 and 197 as indicated by the Fig. 4 and 5 where an atmospheric pressure cracking still is shown.

Pielsticker, British Patent No. 1,308, of 1891, describes such a process using it under pressure, and similarly, Pielsticker in the corresponding United States Patent No. 477,153 of June 14, 1892, describes such a process.

In the Russian patent to Schuchow & Gavrilow patent No. 4,782, of 1891, the upper part of the dome A would have also this effect and would possibly be used for this same purpose; at least, it could be so operated as to be used in this way.

In the Atwood United States patent, No. 28,448 of 1860 (This is Petitioner's Exhibit No. 80) the chamber marked M on Fig. 1 is such a separating chamber or run-back and is described in detail at the top of the first column of page 3, and represents here an air-cooled run-back, using atmospheric pressure on a cracking still. My attention has been called to the fact that on page 2 of this patent, the letter "I" represents a weighted safety valve on the dome of the still, through which vapors can escape, where, through any cause, the worm becomes chocked. This would imply that the still was intended to be operated under slight pressure.

Q. Will you please state whether or not in any of the art you mentioned, or other art prior to 1909, you have found a disclosure of an apparatus comprising an elongated retort of restricted cross section, means for continuously supplying oil under pressure to said retort, means

for locally applying high heat to the restricted volume of oil in said retort to convert or crack the same, means for maintaining the generated vapors under pressure in contact with the surface of the oil in said retort, and means for condensing the vapors, means for continuously supplying oil under pressure to said retort, means for locally applying high heat to the restricted volume of oil in said retort, to convert or crack the same, means for maintaining the generated vapors under pressure in contact with the surface of the oil in said retort, means for collecting and [fol. 171] returning to the source of supply portions of unconverted liquid carried by said vapors, and means for condensing the remaining vapors?

A. I find such described in the Dewar and Redwood patent, United States patent No. 419,931, of January 21, 1890, and a similar description in the Redwood Petroleum, Volume I, page 321, of the 1896 edition.

I find this also disclosed in the patent to Pielsticker, British patent, No. 1,308, of 1891, and also in a similar patent to Pielsticker, United States patent, No. 477,153, of 1892.

The Master: Is that claim 14?

The Witness: Yes, sir. I find it also described in the Laing article in the Transactions of the Royal Scottish Society, Volume 13, of 1894, pages 151 to 162, and in the United States patent to Laing, No. 471,291, and 488,767, particularly when taken together, though, in one of them he speaks of operating under very little pressure.

Q. Will you please point out the elements that form the return, or run-back, in the Laing patents—or, rather, the means for collecting and returning to the surface supply the portion of the unconverted liquids carried by said vapors?

A. I refer particularly to the portions of condensers M-1, M-2, and M-3, in Fig. 2 of the United States patent, No. 488,067.

It is to be noted that this condensate will probably be a much more complete condensate than in the case of such apparatus as that described by Dewar and Redwood.

It will, however, return to the cracking vessel below, the condensate, the vapors condensing there and in that sense it may be considered as a run-back.

Q. Have you read, and do you understand the disclosures of Humphreys' patent No. 1,119,700?

A. I have read it, and I understand it.

Q. Will you please compare the disclosures of this Humphreys' patent with those of Burton patent, No. 1,049,-676?

A. The Humphreys' patent covers practically the same process as that of Burton patent mentioned, excepting that we have the use of a run-back as an added item of the process. Both of them crack under pressure and carry out the process essentially in the same way, excepting that Humphreys' is using a dephlegamator, or run-back.

The Master: Shown where on the drawings?

The Witness: On the drawings this run-back is indicated [fol. 172] by the portion of the apparatus marked with the Fig. 4, which is an air-cooled, large pipe, and the liquid which may be condensed by the air cooling will run back along the lower part of the pipe into the still, 3.

Q. Where do the vapors from this run-back go?

A. They go into a condenser which is indicated in Fig. 1 by the apparatus marked 7, which is a coil within a vessel of cooling liquid.

Q. In your opinion, then, the Humphreys' differs from Burton merely in the insertion of this run-back between the still and the condenser?

A. That is correct.

Q. Referring to the file wrapper of the Humphreys' patent, No. 1,119,700, do you find any comments relating to this feature?

A. In paper No. 2, consisting of the Examiner's letter of August 20, 1914, we find, near the bottom of the letter, this wording:

"The third claim is rejected upon the same references, in view of Burton No. 1,049,667, of January 7, 1913. All claims are rejected."

Then, in paper No. 3, received at the Patent Office, October 30, 1914, the applicant, through his attorneys, in an amendment to page 4 of the specifications, says:

"Cancel the paragraph beginning with line 14, and substitute," while, as heretofore stated, I prefer to hold the

vapors under pressure throughout their course, and while undergoing both the initial and final condensation, as, by controlling the relief pipe 9, it is manifest that the pressure controls the final condensation. That is, the condensation of light vapors, which pass from the run-back, is not essential to the invention. Such fractional condensation as occurs in the run-back itself, however, should evidently be under pressure, for the carrying out of my process, as, otherwise, there would be considerable difficulty in returning the condensed fractions to the still for further treatment therein."

Q. Did you find in this file wrapper any argument on the objection in view of Burton and the prior art, showing the use of run-backs?

A. Accompanying the paper, No. 3, from which I last read, is an affidavit in which Humphreys ante-dates the Burton and Leffler patents, and in this he describes a run-back as a pipe section leading at an upward inclination [fol. 173] from the upper portion of the still and exposed to the atmosphere, and that he used the same prior to July 3, 1912.

Q. Please state whether or not, to your knowledge, the art which you have described, or, other art prior to 1914, contained any disclosures of the method of treating liquid residue of the paraffin series of petroleum distillation having a boiling point of upward of 500° Fahrenheit, to produce therefrom hydrocarbon oils of the same series, but of lower boiling points, which consists in distilling the high boiling point hydrocarbons under a pressure of upward of four atmospheres, cooling all the vapors passing from the still to condense the heavier fractions thereof and simultaneously returning the condensed heavier fractions to the still to undergo therein further treatment and leading off and condensing the light vapors, maintaining such distillation pressure of upward of four atmospheres in said vapors throughout their course to and while undergoing condensation?

A. We would have, as described in the earlier literature—that is, the literatrue before 1914—Pielsticker's British patent, No. 1,308 of 1891, which described the process essentially as you have made inquiry, the final condensation being not under pressure, however. It meets the first

part of your question, but not the phase of the final condensation being under pressure. Lang, United States Patent No. 854,575, of April 12, 1910, also describes such a process, including the condensation under pressure.

Redwood & Dewar, United States Patent No. 419,931, of January 21, 1890, describes such a process, including condensing under pressure. The exact pressure is not given, of four atmospheres, but they do state that it works under high pressure—in other words, it is not limited, as is the question, to the pressure of four atmospheres.

The same is true in connection with the Redwood Treatise on Petroleum, Vol. 1, page 321 and 322, published in 1896.

Lang, in his United States Patent, describes cracking under pressure, and in one of these, No. 471,291, of March 12, 1892, uses a pressure of 80 pounds, which would be somewhat over four atmospheres. He does suggest a use of other suitable pressures, depending upon the oil operated upon. He condenses at atmospheric pressure.

In each of these cases that I have suggested, there is one form or another or a runback.

Q. In the Laing patents that you have described, do you [fol. 174] find any mention of the type of oil treated—that is, its boiling point and gravity?

A. Yes. In Patent No. 471,291, page 1, beginning at Line 78:

"It may, however, be stated by way of example, that I believe 80 pounds per square inch would be found a suitable pressure for operating on a mineral oil of .970 specific gravity, in order to obtain therefrom an oil of about .700 specific gravity."

Q. What type of oil would .970 specific gravity be?

A. It would be quite heavy oil. It might even be a residual oil, and the product of .700 would be in what we would know as a gasolene—in fact, a quite low boiling gasolene.

Q. What would .970 be expressed in Baume gravity?

A. It would be a Baume of about 14.2 degrees.

Q. Would an oil of Baume gravity, 14.2, boil over 500 degrees Fahrenheit, as a rule?

A. Yes.

Q. Have you read, and do you understand the disclosures of the Lewis & Cooke Patent, No. 1,392,584?

A. I have read it and I understand it.

Q. In the specification of this patent there is an element, No. 4, which is termed a fractionating column—will you please explain what is commonly known as a fractionating column?

A. A fractionating column is a piece of apparatus commonly used in connection with stills, where it is desired to make an exact, or close separation of the constituents. It takes many forms, one of the more commmon forms being a plate and cap form, such as is illustrated in the Lewis & Cooke Patent, 7. The vapors pass in at the bottom of the still—of this column—and passing upward meet the liquid which has been condensed, and give up to the liquid their heavier constituents, and permit the lighter constituents to pass on through the various parts of the column, until it reaches the top and passes out from there to a dephlegamator, or to a condenser.

In many respects it is simply an efficient type of run-back, a much more expensive type of build, but more efficient in its operation.

It is normally arranged with a dephlegamator at the top, so that the exact amount of return material will not be de- [fol. 175] pendent upon the question of air cooling—that is, upon the weather.

Q. Will you please explain the purpose and action of these successive plates?

A. When such a tower is in active operation, and has reach equilibrium, then there will be on each plate a liquid of a particular boiling point. As we pass upward through the column the plate above will have a liquid with a lower boiling point, the plate above that with a still lower boiling point, and so on through the 18 or 20 or 40 plates, as the column may have.

In each case the vapor, on passing up from one plate to another, is washed by the liquid above it, and to a considerable extent, the constituents are removed from the vapor, which boil at temperatures above the boiling point of the liquid which is serving to wash these vapors. It must be borne in mind that on each of these plates the liquid is actively boiling, due to the vapor passing through

it, and there is a continual interchange of constituents between the liquid and the vapor. From the top of the column the vapors will be carried away to a condenser, generally of the ordinary coil type, or it may be of other types.

Q. What causes the vapors coming through the liquid, to give up portions of their constituents, and to evaporate lighter fractions from the liquid?

A. The vapors passing upward are hotter than the successive layers of liquids with which they come in contact, and, accordingly, the liquid will be heated and the vapor cooled. The heating of the liquid will cause it to give up its lighter boiling constituents, and the cooling of the vapor will cause it to condense its higher boiling constituents. So that we have, in effect, an interchange between the two, and, as there is additional cooling in this particular type of still, air-cooling, and in other types by the use of the dephlegamator, cooled by a cooling liquid, we will have a passage down through the plates, of certain amounts of liquid, whenever the level of the liquid on the plate gets above a certain point.

This is illustrated in the figure of the Lewis & Cooke Patent, by the Pipe 9, so that whenever, on Plate 7, the liquid rises to a height beyond the upper projection of Pipe 9, it will overflow through Pipe 9, down to this plate just beneath it. I spoke of that as Plate 7—it is Plate 6—I should have said Plate 6.

[fol. 176] Q. Is the operation of the runback affected, to any extent, by the pressure change, or is it the same for all purposes?

A. It works well, whether worked at atmospheric pressure, or above atmospheric, or even in a partial vacuum. The exact pressure used in the column is of minor influence, relative to the effectiveness of the column, or a runback.

Q. Were fractionating columns of this type known, to your knowledge, in the art prior to 1917?

A. They had been well known for many years previous to that time.

Q. Will you please state whether or not to your knowledge the art prior to 1917 contained a disclosure of improvement or a method in the art of cracking petroleum oils by distillation under pressure, which consisted in put-

ting a mixture of sufficiently cracked and insufficiently cracked vapors continuously produced within the still through a plurality of separated bodies of petroleum oil arranged in series, such for example as the fractionating columns and maintaining a temperature such as to condense the unsufficiently cracked fractions but not to condense the sufficiently cracked fractions and condensing and collecting the sufficiently cracked fractions which escape condensation in the said liquid bodies?

A. Pielsticker, British patent No. 1,308 of 1891, describes such a process and shows, in Fig. 8, such a column, W. He also describes W on page 2 of his patent as a column still. A similar column still is described in Pielsticker's United States patent, No. 477,153, Fig. 10, which is to be used in the way your question has indicated.

Barbet French patent, No. 322,265, published January 31st, 1903, uses a cracking still connected with a column and operating under five to six atmospheres and returns the product—the uncondensed product to the still. He does this in a somewhat round about method, but still does accomplish it.

Barbet United States patent, No. 836,732, also describes such a process. I should add that such a bubble tower or column is but an improved type of run-back and that the type indicated by Lewis and Cooke is even at that not the type which is commonly considered to be the most efficient. It is only a moderate improvement and is not as efficient as the types which had been in use even for a generation before Lewis and Cooke's application, though they were not used, as far as I know, on petroleum work.

Q. In your opinion, would there be any difference in result whether an oil being cracked—whether the vapors of [fol. 177] the oil went directly through a fractionating column, as shown in the Pielsticker patent, or whether its pressures were reduced and it suffered an atmospheric pressure distillation and treatment in the fractionating column?

A. The results would be essentially the same.

Q. Do you know of any statements in the file wrapper of the Lewis and Cooke patent that would support your opinion?

The Master: Mr. Wiles, do you regard the Lewis and Cooke patent as distinctly a method or process patent to distinguish from an apparatus patent?

Mr. Wiles: I believe it is a process patent.

The Master: There is some language used here that refers to apparatus; it appears to me, although it is entitled "The art of distilling."

Mr. Wiles: In general, our position is that you can get certain process results on certain particular products by the use of this particular apparatus, and the apparatus may be mentioned in such a way as to accomplish certain—

The Master: None of the claims apply to an apparatus.

Mr. Wiles: None of them would cover the manufacture, for example, or its structure and sale on the market, though all go to its use in a particular manner.

A. In paper No. 4 of July 25th, 1918, we have the Examiner's letter, the last portion of which reads:

"The claims are again rejected upon the reference of record for the above reasons. If this rejection shall be traversed, applicant is requested to file a verified showing as to the efficiency of the process, including that alternative where in high pressure is employed only in the retort, 1, the vapors being permitted to expand before entering his fractioning column."

Then in paper No. 5, the reply of the applicant through his attorneys, amendment B, received July 24th, 1919, at approximately a year afterwards, on page 3, or rather on the bottom of page 2:

"While the fractioning column or bubble tower has been long known in the oil industry as in others, it has never attained any continuous commercial use. In point of fact, while well understood it is practically non-existent, so far as the oil industry is concerned, whatever benefits are derived from its having been so slight in the past that mechanically simpler structures have been employed. The bubble tower, however, as a peculiar and highly important effect upon the vapors produced by pyrogenesis and this particular use of the bubble tower is of the utmost commercial importance for the reasons shown in the Shaeffer affidavit."

Which I will read a portion from in a moment.

"This applies not only in the case where the bubble tower is under pressure and refluxes to the still, but to the alternative procedure concerning which the examiner inquires. The major advantages, however, obviously occur when the process is practiced as described in the present application but there is certainly a patentable advantage in alternative process included within Claim 1, and more expressly covered by the added claim."

Now, referring to the last page of the accompanying affidavit by Shaeffer, this affidavit bearing the date of July 22nd, 1919:

"Our experience therefore, has demonstrated that it is of the utmost value to pass pressure still vapors through a bubble tower of the form shown in the present application. Even after the vapors have gone over and condensed as in the radiator type of still, their re-vaporization and passage through the bubble tower vitally modifies their characteristics with the results above stated. So important is this effect that it is now the practice at Whiting to run quantities of radiator distillate through a bubble tower still at a very low pressure in order to obtain the advantages of the modification wrought in the resulting product by passage through the bubble tower."

Q. It is your conclusion from this affidavit that the process worked equally well at atmospheric pressure as air pressures?

A. That is my understanding from it.

[fol. 178] Q. In the Barbet patents what was said in regard to the use of pressure in the cracking of the oils?

A. The pressure of five to six atmospheres is suggested as a desirable pressure.

Q. How does this pressure compare with their use in the Lewis and Cooke process?

A. On page 2, line 114, "The distillation is conducted under a pressure of five and one-half atmospheres", which would be mid-way between Barbet's five and six atmospheres.

Q. In the Barbet and Pielsticker patents are the liquid bodies connected and discharged one into the other in a direction opposite to the flow of the vapors?

A. I do not understand the meaning of the words "liquid bodies".

Q. The liquid bodies that I have reference to are the bodies of the liquid of the plates and fractioning column?

A. They are.

Q. In the Pielsticker device or process are the condensates returned from the fractioning column to the still or retort?

A. The figures do not indicate plainly as to whether they are or not, but the specification states that they are returned; that is, that the column takes the place of a run-back, such as is indicated in the figure R.

Q. Is there any alternative device that would give the same result in the fractionating column, in which there would be no separate bodies of oil at successively lower temperatures?

A. Yes. For example, those types of columns which are used in acid plants or in the modern near-beer plants for removal of alcohol, or in many types of plants where pressure is wished. The plate and cap type illustrated by Lewis and Cooke is much more easily built when built in successive sections; however, when, as this means, that each section has a chance of leakages at the joint, it becomes much better practice from the chemical engineering view-point to use a column of different type, preferably one filled say with the so-called Rashig rings, or with ring filling of other types, or with the modern so-called tower filling used in acid work and acid plants. These are equally effective, in fact may be made more effective than the plate and cap type, and also are much more convenient to use when pressure is used or vacuum.

Q. Have you read and do you understand the disclosures of the Hall patents?

The Master: Wait a minute. Before you go to that Hall patent, I want to ask a question.

Turning to the patent of Humphreys, No. 1,119,700: Assuming that the method described and claimed was shown by the prior art with the exception that the patent calls

for higher pressures and temperatures, what effect would the higher pressures and temperatures have upon the product or material—resulting material?

The Witness: Essentially none. Its only effect would be in speeding up the operation. We would get essentially the same type of product but we would have to run our apparatus much slower.

The Master: From your general knowledge of the prior art, was that fact known?

The Witness: Yes, it was known even as early as 1861 due to the experiments of petroleum carried out in Newark with a still whose upper portion was left exposed to the air to cool and condense there and the liquid dropped back as liquid into the still.

The Master: That is all.

Q. In the French patent to Barbet, No. 322,265, is any- [fol. 179] thing said about the effect of speeding up the cracking reaction through the use of pressure?

A. What is that number, please?

Q. No. 322,265.

A. On page 5 of the translation we have the statement:

"Due to the agitator and to the pressure the cracking is produced more quickly than in the black pots at atmospheric pressure."

This would be——

Q. Then what particular pressure does he specify?

A. He specifies in two lines above that, "the boiler is made of thick plate of a make capable of supporting five or six atmospheres pressure."

Q. In the pressure still portions of the Barbet patent, how does the treatment of the oil compare with that of the Lewis & Cooke boiler or still portion?

A. It is essentially the same. We have in the Barbet a moving paddle to stir up and to agitate, which is not present or is not shown in the Lewis & Cooke. We have a drawing off of the vapors above, which is in the Lewis & Cooke, but in addition, we have a drawing off of a part of the liquid below and putting it into the column which is, again, not shown in Lewis & Cooke, but the general effect is the same and the use of the column essentially the same.

Q. How does the structure of the column compare with that of Lewis and Cooke?

A. It is of the better type, inasmuch as it carries a dephlegamator more than that of Lewis and Cooke, but otherwise than that it is essentially the plate and cap column of Lewis and Cooke.

Q. In speaking of dephlegmators in connection with these fractionating columns, is this dephlegamator for the purpose of creating a run-back or return condensate?

A. Yes, into the column. Otherwise than that, the column works irregularly due to varying atmospheric conditions.

Q. Have you read and do you understand the disclosures of Hall patents, No. 1,242,795 and N. 1,242,796?

A. I have read, and I understand them.

Q. From your reading and understanding of these two Hall patents, did you find in either of them any disclosure of a pressure still having a reflux condensation or run-back for condensing and returning heavy constituents through a still?

A. I did not.

[fol. 180] Q. What do you consider to be the most characteristic feature of these Hall patents?

A. The first of the two patents has an intermediate cooling, in which we have the equivalent of a run-back, except it does not run back into the still. That is, he cracks at four atmospheres and cools at 200° Centigrade, which would be 392° Fahrenheit, and then cools to atmospheric pressure, or atmospheric temperature or temperature of the cooling water, at least. It is to be noticed that he does not lower the pressure as an intermediate step, whereas in the second one, the patent No. 1,242,796 he cracks under pressure of about the same, then he lowers the pressure and cools; then recompresses and condenses the vapors—the remaining vapors. The essential end or characteristic end in the second one is the lowering of the pressure, say, to 25 pounds pressure from 70 pounds pressure as an intermediate step in the process. It is this lowering of the pressure which is the new element in this Hall patent, No. 1,242,796, which new element is most characteristic of the process.

Q. Did I understand you to say that after cooling and removal of the heavier constituents the vapors are then compressed?

A. In the second of the two patents that is correct. Well, that is true in both patents, I beg your pardon, but only in the second one is there a cooling—a lowering of the pressure and cooling, but in both patents there is a compression before the final condensation.

Q. What is the purpose and function of this compressing of the vapors?

A. He states that by such compression there will be a chemical affixation between the gases and the liquid, a statement which I doubt very much.

Q. Will you please compare the processes described in these Hall patents with those described in the pressure still patents, such as that of Burton, or Dewar and Redwood?

A. In the Burton patent we have described a process in which we carry out a cracking of the vapors under pressure, as in the case of the Hall, but in the original Burton process we do not condense at a temperature of approximately 392° Fahrenheit, as does Hall, and take off that portion. The final condensation is made under pressure of the same pressure as in the still in the case of Burton, but in the Hall it is made at a pressure not less than that but may be more than that in the still.

[fol. 181] In the case of Dewar and Redwood we have essentially the same as in the case of Burton, excepting that there is a separation of the heavier vapors by a run-back or a condenser, and if this was kept at 200° it would be somewhat parallel to that of Hall, but would differ from it in that this portion condensing at 200° in the Dewar and Redwood patent, would be run back to the still directly while still hot; whereas, in the Hall patent, it is not necessarily run back at all into the still.

Q. Referring to the Hall patent, No. 1,242,795—do you understand the cracking process taking place up to the coil B, to be a vapor phase, or liquid phase cracking?

A. It is essentially a vapor phase cracking process.

Q. About what temperatures are required—that is, what temperatures in the coils are required to accomplish this cracking in converter, A, of Hall?

A. Around 650° Centigrade, which would be 1,202 Fahrenheit.

Q. How does this compare with the Burton cracking still?

A. It is decidely higher.

Q. Is there any similarity between the process of the converter, A, and the Burton tubular still, or shell still, other than the fact that they crack?

A. And that its cracking is about at the same pressure. The two are quite different. One is vapor phase, and the other liquid phase. That is, one heats and cracks the vapors and the other heats at a lower temperature and handles the liquids and cracks them while they are still in the so-called liquid phase.

Q. Do you know of any processes in the prior art, similar, in any way, to the process carried out in converter, A?

A. There are several vapor phase cracking processes which have been described in the prior art.

Q. Aside from the feature of vapor phase cracking, are there any disclosures in the art, prior to 1914, of cracking in a tube?

A. Yes, but there are none so far as I recall, that at the later steps, compress before condensing—as an intermediate step.

There are a number of citations which—there are a number of descriptions in the prior art, which crack in a tube, some in liquid phase and some in vapor phase, but none which, to my recollection, compress just before condensing, as does Hall, in both the patents, Nos. 1,242,795 and 1,242,796.

Q. Then you consider the compressing to be most characteristic of all of the Hall process?

A. It is peculiar to Hall, but in the No. 1,242,796, we have, also, the other phase which is characteristic—that is, the lowering of the pressure as an intermediate step, and then following it by re-compression, as I indicated in my testimony this morning.

Q. Do you know of any comparison in the file wrapper of Hall patent, No. 1,242,795, between the process of this patent and that of the Burton patent?

A. There is such a comparison.

The Master: Do you mean that there is an additional step carrying forward the process of distillation beyond that usually employed, in one entire operation, or is it an isolated process, beginning with the derivatives, in the ordinary processes of distilling?

The Witness: It is not quite either. It is a different type of process than any shown in any patents which we have discussed before, inasmuch as the other patents have dealt with liquids which, while they were still liquids were heated and cracked. Hall changes to vapors and then cracks these. So that it is using a temperature high enough so that the oils are present as vapors and then he cracks those vapors.

The Master: That you have distinguished by the term vapor phase cracking?

The Witness: Exactly, and also the Hall is distinguished, [fol. 182] inasmuch as in each case it compresses before it condenses, and attaches special significance to that.

Also, in some cases—or, in one case, in Patent No. 1,242,796, there is a high pressure and a low pressure, and a high pressure which may be higher than the original one, before it condenses.

The Master: Would the result of this patent be the obtaining of a larger quantity of motor fuel from the same quantity of crude?

The Witness: I don't think that actually there would be so produced a larger amount of motor fuel from the same quantity of crude. There is a claim though,—there is an assertion here that the product so obtained is a different type of product from what we have had before, in that the gases are chemically affixed to the liquid.

The Master: One of the advantages named is a greater increase in volume of fuel produced, over the volume obtained by any of the processes, depending entirely upon cracking.

The Witness: Let me state that I don't believe, personally, that that is correct. I also refer, as well, to the chemical affixing—say the last portion—well, page 3, line 82—"produces a chemical affixation of the gases and vapors." That is the last part of Column 3.

Q. When you speak of crude oil you don't mean crude petroleum as it comes from the ground, do you?

A. No, not necessarily. That might be the treatment of a residue, from a straight distillation for gasolene, or kerosene, or you could use a heavy straight petroleum, just as it comes from the ground—either one. This chemical affixation is also given on page 1 of Patent No. 1,242,795, in the last full paragraphs, in Column 1.

The Master: Does that mean that it is a step up to a higher series of the derivatives of petroleum?

The Witness: Frankly, I don't know its true meaning.

The Master: It refers to the ethylene series—is that something different from the series with which we have been dealing?

The Witness: No, the ethylene series are those which we have been calling the unsaturated series, but when I spoke of the part that I can not clearly explain, or accept, I referred to the process which will take the gases containing butane and pentane, and affix those to the vapors, or unsaturated hydro-carbon, referred to as a "liquid base."

Referring, now, to the file wrapper of the Hall patent, [fol. 183] No. 1,242,795, as to the evidence there, relative to distinguishing the Hall process from that of Burton, I would call your attention to paper No. 5, from the attorney of the applicant dated as being received January 14, 1915.

Page 5 of that paper reads as follows:

"In regard to the Burton cited against Claim 2—the correct number of the patent apparently being No. 1,049,667—the process of this patent apparently does not produce any hydro-carbons of the ethylene series. The file wrapper of this patent shows very conclusively—in the form of certain affidavits incorporated therein—that the produce consists of hydro-carbons of the saturated series, exclusively. It is noted that this patent further does not show the high cracking temperature which applicant employs. Hence it could hardly be expected that the same results would be secured."

The Master: What I would like to know, Doctor; is the product produced by the methods disclosed, a new product in the art?

The Witness: I scarcely know how to answer your Honor, in that respect, because, personally, I am of the opinion that the applicant was entirely mistaken as to the character of the product which he describes here. And I am of the opinion that the product obtained was essentially the same kind as we have been using heretofore, though he describes it here as if it was a different kind of product.

The Master: Assuming that the product was well known to the art prior to his time, what is the new step in his method?

The Witness: The compression just before condensing.

Continuing from the file wrapper: In Paper No. 6, as furnished by the attorney for the applicant, to the Patent Office, and received by the Patent Office on January 20, 1915, there is an accompanying letter, relative to the differences between the Burton process and this process of Hall. This letter bears the date of November 16, 1914. I quote:

"You ask me to write out for you the difference between the Burton patent and our principal patent. There is such an enormous difference that it is almost futile to point it out. In fact, there is no analogy, at all, excepting that each are for cracking processes. Although, in ours the cracking is merely an incident, and far the least important point. Whereas, in Burton it is substantially the whole thing, excepting that the distillate is condensed under pressure. The Burton patent appears to me, and to about everyone else [fol. 184] with whom I have discussed the matter, as closely analogous, if not identical, to the old Dewar & Redwood patent, long since expired.

In each of these oil is cracked in a cylindrical still, and heated to a maximum temperature of about 450° C. This is a temperature far below the minimum that we can use. In fact, if we operated under such a temperature we would have substantially no results. This is the first, and at the same time a most important difference. The Burton process is not continuous—that is, if the vapors distilling from the body of oil in their still, passed directly out in continuity, there would be substantially no cracking to such portions. It would be simply a fractional distillation. Their cracking is produced by portions of the vaporized oil con-

densing at the top of the still and dropping back, and this repeated, times enumerable, which anyone can readily see is totally different from cracking in a continuous coil, where there is no dropping back or repetitions, and the fuel economy is infinitely greater. The entire volatile products, including cracked and uncracked, coming from the Burton still, passes under as near the pressure of the still as practical, through a cooling condenser, and condenses under pressure as near to that of the still as is practicable."

There is still further discussion of it, but I think it is of little importance.

Q. In reading this patent and the file wrappers, would you conclude that the temperature ought to be about 600 or 650?

A. I would, for the Hall process, No. 1,242,795.

There is one place in the file wrapper where a lower temperature is mentioned, but that is not clearly indicated as of the Hall process. It is a discussion as to the effect of pressure when temperatures of 500 or 600 degrees are used.

I refer to paper No. 22, page 4, line 24.

But the general implication, through the patent, is that a temperature of at least 600° must be used. For example, page 4, line 5, in which it is said, "A temperature of at least 600° C. must be used."

Q. Referring to paper No. 35 of the file wrapper of Hall patent, No. 1,242,795——

The Master: Before you go to that, Mr. Rauber,—what is the effect upon vapors and gases, by compression?

The Witness: It makes them easier to condense, and, consequently, you can use a smaller condenser, also, you can, if you desire, get the lighter—that is, the more easier boiling constituents by the same degree of cooling.

[fol. 185] The Master: Are they cooled in compression?

The Witness: Yes, in the Hall patents.

Q. What change is there in the energy content of the gases, when compressed?

A. Compression of a gas warms the gas—in other words gets free heat from the gas, and we have accordingly, that when the gas is passed into the condenser, there is a bigger

difference of temperature than there otherwise would be. In other words, the condenser would work more readily than if it was condensing at atmospheric pressure, or still more readily than if it was condensing in a pressure vacuum.

Q. If you have a gas containing something that would crack, and compressed it sufficiently, would you succeed in raising its temperature to a cracking temperature?

A. Yes, sir. I have seen a cracking process carrried out at Toronto, in which the cracking was brought about by running it through a high pressure compressor, the compressor compressing the gas suddenly, and thereby increasing its temperature to a point where it would, and did crack, to give gasoline hydrocarbons or motor fuels.

Q. Do you get the same result in compressing any gas, as to heating?

A. Yes, all gases heat when compressed. It is one method of heating a gas, but of course, not the cheapest method.

Q. Can you heat a liquid by compressing it—or putting it under pressure, rather?

A. Yes, if it is compressible. Many of our liquids have very slight compression, and to put, for example, water under pressure, it is very difficult to get a rise of, say, three degrees Fahrenheit, by putting water under compression. On the other hand, by taking some solids, such as ice, which has a greater volume than water, by putting it under pressure we can change it from a solid to a liquid—at least, if we don't start with it too far below 32° Fahrenheit.

Q. Where you compress the ice, it would raise or lower its temperature?

A. We would raise its temperture.

Q. Did you ever crack a liquid under pressure—simply by putting it under pressure?

A. I think we have no chance of doing that, of cracking a liquid such as petroleum, by compression methods only.

Q. Returning to the file wrapper of the Hall patent, No. 1,242,795,—paper No. 35, page 4,—do you find anything [fol. 186] there that would indicate that Hall's invention was different from that of Burton's?

A. Referring, not to page 4, but first to page 3 of this paper No. 35, which is a decision on a hearing held April 12, 1917, before the Examiners-in-Chief, and carries the

date of August 23, 1917—we find on page 3 of this paper No. 35, near the bottom of the page, this:

"Claims 4 and 9 involve only the step of cooling mixed gases under pressure. Specifying, however, that those gases are such as are volatile at about 200 degrees C. We do not see that the effect of this step is any different with gases of this kind—" I think this is a misprint for "them" —"than would those of Blaw, who also cools his gas under pressure."

Then, in the last two lines on page 4, the decision of the Examiner is affirmed as to claims 4 and 9, and reversed as to the remaining claims."

These Claims 4 and 9 were those involving only the step of cooling mixed gases under pressure, and I may add that in Paper No. 38, from the attorney of the applicant, which was received at the Patent Office on September 1, 1917, he amends the application by cancelling Claims 4 and 9, and renumbering the remaining claims. In other words, he accepts the decision.

Q. Will you please state whether or not, to your knowledge, the art, prior to 1914, contained any disclosure of a process of cracking hydrocarbon oils at a temperature sufficiently high to convert a portion of the oil into fixed gases, and to produce vapors containing considerable percentages of unsaturated hydro-carbons, cooling the vapors and gases sufficiently to cause the portions having boiling points of about 200 degrees centigrade, to condense out, and, thereafter subjecting the resulting gases, or vapors, at a temperature of 100 to 200 degrees centigrade, to a pressure of not less than about 70 pounds per square inch?

Mr. Clark: What claim is that, Mr. Rauber?

Mr. Rauber: That resembles, in some respects, Claim 3 in Patent No. 1,242,795.

A. If Dewar & Redwood were using as their pressure, which they designate as "High Pressure" and as mentioned in their United States Patent No. 419,931 of January 21, 1896, and ran their dephlegamator or runback at the temperature given, that is around 200 degrees centigrade, this would be a process fully meeting the process which you have described.

[fol. 187] Dewar & Redwood do not state just what pressure they use but state that it is a 'High pressure,'' which I presume would be the pressures that you have stated, and not less than 70 pounds per square inch. Also they do not state at what temperature they handle the run-back but as the process is a cracking process, it would be in the general range of 200 degrees C.

Q. Do you know of any process of the art prior to 1914—any disclosure of the process, rather, in which vapors from a cracking still are condensed at 200 degrees centigrade?

A. Yes. There is a Russian writing in a German magazine, I have forgotten his name at the moment. (Referring to documents.) Nickiforoff, United States Patent No. 755,309, of March 22, 1904, describes a process for making benzol and its homologues, and prefers to use a Russian petroleum. He distills and cracks at a temperature of approximately 500 to 525 degrees centigrade. 500 degrees centigrade would be 932 degrees Fahrenheit. He collects separately the distillate below 200 degrees and then recracks to get benzol and toluol.

Q. In the operation of a pressure still with refluxes or runbacks, would there be any particular significance in the use of 200 degrees as a temperature or reflux or runback?

A. The advantage would be that the product obtained from the condenser would be essentially motor fuel; whereas, if a higher temperature was used there would be more of the higher boiling products coming over with the vapors and the yield, so far as motor fuel is concerned, would be less. Using, however, a reflux of 200 degrees, the higher boiling portions would be largely returned to the still and recracked.

Q. Do you know of any other art prior to 1914 that discloses this feature of a runback operated at around 200 degrees centigrade?

A. Lang, United States Patent No. 854,575, April 12, 1910, operates under pressure with a runback, If the proper values were given to this pressure and to this temperature, that is, using pressure here of that above 70 pounds per square inch, and the runback or reflux was operated at 200 degrees it would be a description of this process.

Q. You mean the process described in my question?

A. The process described in your question of a few questions ago in connection with the Hall Patent No. 1,242,795. Lang does not discuss the particular temperatures used [fol. 188] for the reflux but permits air condensation so that they would vary somewhat with the weather.

Q. You did not find any compression in the Lang patent, did you?

A. No, but your question did not call—your original question did not call for compression.

Q. In Reading Adams Patent No. 1,327,263, did you find any elements described that might act as a runback?

A. Yes. The elements described, as shown in Fig. 2, of Pipes 44, 43, 54, and the type of receiver 42 would be cooling elements and the product so condensed would pass down pipe 24, through valve 25, pipe 34 into the lower portion of the retort where it would be heated afresh and recracked.

Q. Will you state whether or not to your knowledge the art prior to 1911 disclosed a method of treating the hydrocarbons of higher boiling point to obtain hydrocarbon oils of lower boiling point, which consists in heating the higher boiling hydrocarbons in a liquid form to a cracking temperature in a chamber under pressure, condensing the cracked vapors produced by passing the same from the said chamber to a condenser, supplying hydrocarbons of high boiling point to said chamber during the cracking operation, to maintain a proper supply therein, separating the heavier product from the cracked vapors at a point between said chamber and said condenser and maintaining connection between said chamber to and through the condenser, an open communication so as to insure a substantial uniform pressure through the chamber and through the condenser and returning said heavier product to said chamber?

Mr. Wiles: Which claim is that?

Mr. Rauber: It is not a claim in a sense, it is a question, but it is somewhat like Claim 4 of the Adams Patent 1,327,263.

The Master: 795?

Mr. Rauber: 1,327,263; Adams.

A. Dewar and Redwood, United States patent, No. 419,931 of January 21st, 1890, described a process corresponding to that disclosed in your question. The same is true in Redwood's Petroleum, first edition of 1896, Volume I, pages 317 to 322.

Further, Lang of United States patent, No. 854,575, of April 12th, 1910, described a process which would also meet your question—meet the process described in your question, and there are several others which would meet [fol. 189] it excepting for condensing under pressure, such as Pielsticker British patent No. 1308 of 1891.

Q. You mean condensing the final product under pressure?

A. Yes. The Pielsticker United States patent, No. 477,153 of June 14th, 1892; Russian patent of Schuchow and Gavrilow, No. 4782 of 1891. I think that is all that I recall.

Q. In the Dewar and Redwood disclosure, is the connection from the cracking chamber to and through the condenser, is that connection an open communication?

A. Yes.

Q. Is the heavier product condensed and returned to the still in the Dewar and Redwood disclosure?

A. It is.

Q. Do you find any mention in the specification of the Dewar and Redwood patent that would indicate that there was a continuous feed of oil into this cracking chamber?

A. Yes. On page 2, lines 21 to 26, we have the statement:

"By another pipe E², furnished with a cock or valve, the contents of the retort can be drawn off or this pipe may communicate with a second retort, which, in like manner, may be connected with a third, so as to form a series of any required number."

This would mean that as far as any individual retort is concerned, it is a continuous process, and the whole might be spoken of as a continuous process, as far as any process is a continuous process in oil cracking.

Q. Have you read and do you understand the disclosures of Manley patent No. 1,462,143?

A. I have read it and I understand its essentials.

Q. Will you please compare the method described in this Manley patent with that described in the Humphrey patent No. 1,119,700?

A. The essential end of the Humphrey's patent was the use of a reflux or a run-back. We have this same idea amplified in the Manley patent. This reflux is carried out somewhat differently but the net result is very nearly the same. In the Manley patent we do have certain other things that are added that are of importance; the use of pressures of from 100 to 300 pounds; the use of steel brush scrapers to remove carbon formed in the cracking tube or pipe, which has taken in this case a vertical pipe-like form.

I think that perhaps the most characteristic feature of this patent may be said to be the injection of the product from the reflux into the bottom of the still, along with the [fol. 190] supply of fresh oil. In Humphrey's the run-back furnishes the condensed liquor to the top layer of the liquor in the still and not to the bottom layer.

Q. Referring back to Adams patent, No. 1,327,263, will you compare the manner of returning the reflux in this patent with that shown in Manley?

A. It is essentially the same, except in the case of the Adams' patent, No. 1,327,263, there is no injection effect, whereas, in the Manley patent, No. 1,462,143, the supply pipe controlled by a valve, 11, and pipe, 10, serves as an injection medium for the condensate returned through pipe 7, and forces it into the still 4, at the point marked 4-A.

However, I may remark that I think there is little point in Manley's idea of injecting such a return condensate. Such a process of injection is unnecessary, as due to the fact that such a case as in Adams No. 1,327,263, the return condensate is essentially free from vapor bubbles and also due to the fact that it is air-cooled, it is, in consequence, heavier than the column of oil of similar height in the vertical still to the right of it, 12, up to the point X, and, accordingly, if it is heavier, it is heavy enough so that it will run into the still while the still is operating. In Manley it is forced in by positive pressure by injection instead, but that is really unnecessary.

In Manley's operation, it would work if the pipe 7 and the pipe 10 had separate points of entrance into the still near the point 4-A.

Q. In the heating of oils or other liquids, does a rapid circulation of the liquid over the heating surface have any effect on the rate of heating or ease in heating?

A. It permits a greater transferrence of heat from the wall of the tube or still to the liquid than if the liquid is essentially stationary.

In other words, in a given period of time per square foot of contact surface, there will be a greater number of heat units such as we commonly designate as British Thermal Units transferred per unit time.

Q. Would this advantage be obtained in circulating oil to be heated through the coils such as shown in the Russian patent to Schuchow & Gavrilow Petitioner's Exhibit No. 129, or in the Pielsticker British patent, Petitioner's Exhibit No. 1337?

A. It would, in each case.

Q. Do you know of any other instances in the art prior to 1912 showing the practice of circulating liquids through heating coils, or prior to 1909, for the same purpose?

A. It was a common expedient to do so.

German patent No. 166,723, to Clercq's patent der Gesellshaft of January 10th, 1906, circulates tar or other oil forcibly and rapidly in a small stream through a heated coil and would be a good illustration of such a process.

Q. Will you please state whether or not you know of any disclosure in the art prior to 1909 of an apparatus which comprises an unheated drum and a coil discharging thereinto, means for continuously supplying oil under pressure to said coil; means for locally applying high heat to a restricted volume of oil in said coil to convert or crack the same, means for maintaining the generated vapors under pressure in contact with the surface of the oil in said drum, and means for condensing the vapors?

[fol. 191] A. Schuchow & Gavrilow, Russian Patent No. 4782 of 1891, discloses a process meeting all of the conditions mentioned in your question.

Q. Will you please compare the heating arrangements of the Schuchow, et al., patent with those of Adams Patent No. 1,320,254?

A. The heating arrangements in the Schuchow & Gavrilow Russian Patent, consisting of coils or of straight pipes; the figures show only coils but the text says that these may

be groups of straight pipes. I refer to line 28 of the first page of the translation:

"The coil tubes may be of various designs and may be replaced by straight ones."

It is an externally heated tube or pipe, whereas, in the case of the Adams it is an internally heated pipe. One is heated with flame in the ordinary way; the other is heated by means of an electrical heater for each pipe. Each can be made in a series: that is, several pipes, and in that respect they are alike rather than different.

One is external heating and the other is internal electrical heating with a heater which is separate from the walls of the pipe in the case of Adams.

Q. In the disclosure in the Schuchow, et al., patent do you find any means for collecting and returning unconverted liquid to the source of supply?

A. Yes, it passes out from the tank 8 through the pipe D, valve Q to the pump B and is forced back through the pipe C to the retort to be cracked afresh.

Q. Have you read and do you understand the disclosures of Adams Patent No. 1,320,727?

A. I have read it and I understand it.

[fol. 192] Q. On page 4 of this Adams Patent No. 1,320,727, the admission of superheated steam is described for the purpose of combining with carbon at what is termed, "An intense heat." About what temperature is required for such a reaction and how does such a temperature compare with those used in the cracking of oil to form gasolene and cracking to form oil gas respectively?

A. The temperature required for the reaction of steam —upon carbon to combine with the carbon will be in general of the range of 2,000 degrees Fahrenheit, or possibly slightly lower than that; whereas, the range required for the cracking of oil is ordinarily much lower, in fact, we get ready cracking at as low as 500 degrees Fahrenheit.

If we are cracking oil to get not motor fuel but gases, say, to make gas like Blaugas or other gas, we will use temperature perhaps of 600 degrees Centigrade, or use a temperature of about 1,000 degrees Fahrenheit, which will be about 500 or 600 degrees centigrade.

Q. You would expect in following the Adams patent, therefore, to use temperatures at higher than those used in the straight pressure distillation?

A. Very much higher. Temperatures in the general range of 1700 to 2,000 degrees Fahrenheit.

Q. That is, to obtain a reaction with steam?

A. Yes.

The Master: Live steam is what temperature?

The Witness: To get reaction with steam about 1700 or 2,000 degrees Fahrenheit.

The Master: What did you say the temperature of live steam was?

The Witness: It would not matter what temperature you put it in at, you would have to have it that hot while in contact with carbon.

Mr. Rauber: The claims say 212 or above.

Q. From reading the specification of this Adams Patent No. 1,320,727, what would you understand to be the pressure used, or whether any particular pressure is to be used?

A. He states in some places here that he used atmospheric pressure and other places—well, page 3, Line 109, he states:

"Owing to the high temperatures employed in conversion process and the consequent volatilization of unconverted oils treated under ordinary atmospheric conditions, I have, by a series of valves and collecting trap tanks pro- [fol. 193] vided means for carrying on this process under vapor pressure of several atmospheres, if found necessary."

Then, on page 5, line 10:

"When converting very low boiling point oils and vapors or those above 65° Baume under atmospheric conditions—"

And on page 5, line 122:

"If a light or medium vapor pressure of not more than two or three atmospheres—"

Page 6, line 80:

"When operating under high vapor pressure, brought about by the expansation, vaporization and retention of oil and oily vapors in dome D—"

Which I understand to be above these pressures of two or three atmospheres, say, above fifty pounds pressure.

Q. Are any changes de-cribed as being necessary to adapt the apparatus for any particular temperature or pressure?

A. You have to change the valving of apparatus, that is, the closing and opening of certain valves, and the pressure of safety and pop-valves, are operated by adjusting them, and in fact the process is operated—or the mode of operation under these various pressures is given separately as if it was quite different, though essentially the same apparatus is used.

The Master: In other words, you mean it is just simply an adjustment of the valves?

The Witness: Yes, and in some cases he did not use all his pipes or valves, but they are all in the apparatus. You can omit a portion of them when he is working at atmospheric pressure, for example, certain safety valves and pop-valves.

The Master: You mean by that that the workmen in charge of the operation could bring the process either within or without the patent by simply turning the valves?

The Witness: He could change from one way of operating to the other way simply by changing the valves. Yes, I should say he could bring it within the patent by changing the valves.

The Master: In other words, the workmen could work an infringement by simply setting the pressure valve at a different amount of pressure?

The Witness: Well, he has made his various pressures so wide here, one portion at atmospheric, another portion lower than fifty pounds, another portion above fifty pounds that a workman would have a hard time finding a pressure that was not included in that. That was any pressure, almost.

[fol. 194] The Master: I knew that to be done once.

Mr. Miles: In an apparatus case?

The Master: Process case. He ran a workman into the fellow's factory and just simply worked an infringement by it by running up the temperature.

Q. Would any particular change be required other than making an apparatus of greater strength to permit it to operate at pressures or under pressures rather than at atmospheric pressure?

A. I think not.

Q. That is, if you had a still that you had operated at atmospheric pressure, you could operate it under increased pressure by simply making it stronger?

A. Oh, I do not know whether I understood your original question. I understood your original question to relate to the Adams patent No. 1,320,727 exclusively.

Q. No, I referred to——

A. In general?

Q. Stills in general.

A. My same answer still holds, that it would not require any essential change in it except making the still stronger.

Q. Will you please state whether or not to your knowledge the art prior to 1915, or particularly prior to 1913, disclosed an apparatus comprising a container for a body of oil embodying means for maintaining the lower portion of the oil relatively separate and distinct from the main body of the oil above; such, for example, as a coil of pipe; of means for subjecting said separate portion of oil to a local cracking or converting temperature and means for maintaining a predetermined vapor pressure on the body of the oil?

A. I believe that the process you have described has been described in the publication of Laing, United States patent No. 854,575 of April 12th, 1910. In this particular case the bodies of oil are contained in pipes—pipe shaped contained under the conditions you have mentioned.

Pielsticker British patent No. 1,308 of 1891 is also a description of the process you have mentioned. Similarly, the Pielsticker United States patent No. 477,153 of June 14, 1892.

The same is true of Schuchow & Gavrilow, Russian patent, No. 4782 of 1891, whether it uses the coil form of retort or the straight pipe form of retort which are described in that publication.

Q. Will you please point out in the Schuchow & Gavrilow [fol. 195] patent what you consider to be the main body of oil and the separate bodies of oil?

A. We have as the separate body of oil, which is subject to the local cracking, the oil in the coils; whereas, the main body of the oil would be oil in the container A, pipe B and through into the pump and through the pipe C and including the pipe. The new oil fed in through the other pipe leading to the pump. We would continuously introduce new oil through the pump and through the pipe C into the coils which are the cracking coils.

Q. Will you please point out in the Pielsticker patent what you consider to be the main body of oil and the separate body?

A. We have in the Pielsticker British patent, No. 1,308 of 1891, best shown in Fig. 9, a cracking oil D', which would be the separate portion of oil subject to local cracking, and we would continuously introduce oil into this through the inlet from the figure to the left, and even from the pipe G, which is attached to the oil feed, coming from the tank 8 through the pump C, as shown in Fig. 1. So that we would have oil coming from the supply of crude oil, through a coil or a vessel here, and then into the cracking oil D'. It happens to be that in this particular case, this passes on to a second cracking vessel, but so far as your question is concerned, we are not concerned with that second cracking vessel.

Q. In the Schuchow & Gavrilow structure you mentioned draw off pipe?

A. Mentioned what?

Q. The draw off pipe?

A. B.

Q. Does this keep the liquid level in the drum A at a constant level?

A. Approximately so. That is, its purpose is to take away all of the surplus liquid from 8.

Q. Have you read and do you understand the disclosures of Ellis patent, No. 1,415,232?

A. I have read it and I understand it.

Q. What do you understand to be the characteristic feature of this Ellis process?

A. I understand what is commonly known as the tube and tank idea to be the essential feature of this patent.

The Master: Which is the tube and which is the tank?

The Witness: You have at the lower part of the figure a [fol. 196] burner 2 there with a series of ends of tubes, marked there 4 and 4-A, I think.

The Master: Oh, yes.

The Witness: And above it a tank 8.

The Master: The tubes 4 are connected through the line 6 into tank A, is that right?

The Witness: Yes, or rather that whole bank of tubes, of which you see the ends at 4, and of which you see nine ends are connected with that—ten ends are connected with the pipe 6 and the second bank with 6-A.

Q. This patent is described as being a division of an application filed November 26th, 1920, serial No. 426,501. Referring to the original specification of this original application, Serial No. 426,501, which has now become Ellis patent No. 1,396,999, do you understand this to be a vapor phase or liquid phase process?

A. This states clearly on lines 17, 18 and 19 that it is a vapor phase process, the quotation reading:

"While the heavier oil passes through in a form of a vapor and is subjected to thermal decomposition during such travel—"

With this further agrees the form of the figure of the tank 8. If it was liquid that was passing through the outlet 9, it would be from the top of the tank, and not from the side. It being from the side would confirm this being a vapor passing out.

Again, on page 2, lines 12 to 20, we have this statement:

"After the oil vapors have been decomposed to the required degree, which ordinarily for single passage therethrough should yield from 20 to 40 per cent of light products adapted for use as a gasoline substitute, the vapors are passed preferably to a digestor, which may be a vessel well insulated to prevent loss of heat, in which container the heated vapors undergo digestion and more or less stableization with the establishment of certain conditions in equilibrium which could not be secured separately in decomposing tubes, where exertme heat is being applied externally."

This, again, would be confirmed by the sketch which I have referred to, because if it was anything else than vapor phase, the upper half of the tank 8 would be useless.

Page 5 of the specification, line 7 from the bottom of the page:

"The products of combustion from the heaters below the [fol. 197] decomposing tubes pass up and around the drum, and in some cases may add heat to it, and in other cases may serve more as an insulating blanket of heated air to prevent any substantial drop of temperature in the digester 8."

Q. Do you understand that the oil is cracked in the tubes 4 of the Ellis patent No. 1,415,232?

A. Yes, in the vapor phase; that is, the first action is to change it into vapor and then to crack it.

Q. Referring back to the file wrapper of Ellis patent No. 1,396,999, the original specification, page 2, line 12, do you find anything that would indicate that the oil is cracked in the tubes.

A. I find the following statement:

"After the oil vapors have been decomposed to the required degree, which ordinarily for single passage therethrough should yield from 20 to 40 per cent of light products adapted for use as a gasoline substitute, the vapors are passed preferably to a digester, which—"

and so forth.

Q. Do you gather from that that they are cracked in the tubes?

A. Yes.

Q. What was the purpose of the drum?

A. Apparently he has in mind a greater or less stabilization of the vapors. For example, on the same page, Line 17, he says: "In which container the heated vapors undergo digestion and more or less stabilization."

Q. Do you understand that there is any cracking in this drum? I ask you to refer particularly to Paper No. 21, a brief filed December 8, 1920, page 3.

A. Beginning on page 2, of Paper 21, which was filed December 8, 1920, as a brief for the applicant, and signed by the attorney in his behalf, we find this:

"Applicant's process is distinguished from that of Palmer, and the Palmer reference, in that the oils are heated to a decomposing temperature before they are passed to the digestor, and are allowed to pass slowly through the digestor without the use of additional heat, whereby they become more or less saturated, and are thus stabilized."

This would imply that the applicant considered that he would get more saturated hydrocarbons, and not that the purpose of the digestor was to break up the hydrocarbons. In other words, to take saturated hydrocarbons would mean an additional reaction, which would mean bringing two [fol. 198] molecules together to form the saturated from the unsaturated, and which would be just the reverse of a cracking process.

Q. What happened to the vapors coming from the drum, in the Ellis Patent, No. 1,396,699?

A. He presumes that they would be taken—after they come to the drum they pass on to the fractionation column, and are there handled and pass on later to—as he indicates in Fig. 3—a hydrogenator, to ad hydrogen to them.

The Master: Do you mean he adds free hydrogen?

The Witness: There will be, in the cracking process itself, some free hydrogen set free, but in Patent No. 1,396,999, he considers that he can, by retreatment there, add hydrogen to it, to make it more saturated, instead of unsaturated olefines.

Q. How does the process described in Ellis Patent No. 1,415,232, compare with that of the patent application for the parent patent, No. 1,396,999, with regard to the step of hydrogenization?

A. There is no step of hydrogenization in the later patent.

Q. Is this the main difference, that the second one omits the hydrogenization step?

A. I would say that was the main difference. There are other minor differences.

Q. Did you find any indication in the original specification of the Ellis application, on which Patent No. 1,415,232 was granted, of the pressure used in the process?

A. In the original specification, page 2, line 12, to 17, inclusive, we find the following statement:

"The slow travel of the cracked oily material within the drum, or shell, enables equilibrium to be established to a certain degree. The process is preferably carried out at a pressure above atmospheric. Such super-atmospheric pressure ranging from a slight pressure to pressure of several atmospheres."

Q. Will you please compare the disclosures of this Ellis Patent, No. 1,145,232, with those of the French patent of Kittle, No. 417,532? I refer particularly to Fig. 1, in Kittle's patent.

A. Kittle's French Patent, No. 417,532, published November 16, 1910, shows a tube and tank apparatus and process, which is working in a liquid phase—that is, he is cracking a petroleum oil while it is liquid.

[fol. 199] The tank is placed above and is subject to pressure, and the whole process is carried out under pressure.

The tube is in the form of a coil, instead of in the form of straight pipes, as in the case of Ellis. The condensation, however, is at atmospheric pressure, or, at least apparently so. Whereas, in the case of Ellis the preference seems to be for condensation under pressure.

There are two differences between the Kittle patent——

Q. I beg your pardon, but in my question I am referring particularly to the manner of heating—that comparison.

A. Oh, pardon me. In Ellis, the tubes are heated directly by means of a flame, whereas, in the Kittle patent, they are heated by means of a bath of molten metal.

Q. In the Kittle apparatus does that bath of molten metal hold the tube and the tank at approximately the same temperature?

A. Yes, sir.

Q. How does this compare with the disclosure of Ellis?

A. It is essentially the same, excepting that Kittle is primarily concerned with a liquid phase process, whereas, Ellis is primarily concerned with a vapor phase process.

The Master: One is under pressure and the other is not?

The Witness: No, they are both under pressure. The condensation is not under pressure in Kittle.

Q. In the Kittle process do you mean to say that there is no vapor formed?

A. No. There is vapor formed, but it is primarily a liquid phase operation. There is some vapor formed, particularly in the tank portion of the apparatus.

Q. Relative to the matter of liquid and vapor phase, in the Ellis process,—and I refer you to Paper No. 8, of the file wrapper of Ellis Patent No. 1,415,232—this paper being marked, "Amendment "D," filed December 14, 1921—on page 3 of this paper, at about the middle of the page, do you find any statement in regard to the phase at which the Ellis patent is operated?

A. He states:

"Briefly, therefore, applicant's process will, in all cases, probably be a mixed phase process, so far as concerns the contents of the chamber, 8, and it will be just as operative with one oil as the other. Applicant, therefore, should not be required to limit himself to either phase, alone since, in point of fact, it would be practically impossible to operate a process like applicant's in one phase only."

[fol. 200] And that is, of course, what I said in regard to the Kittle patent, that it has both liquid and gas phases, but primarily liquid, whereas, the Ellis process is both liquid and gaseous phase, but primarily gaseous, or vapor phase.

Q. Aside from slight changes in the extent of liquid, or gas in the system, do you mean to say that the treatment and heating of oil in a tube and tank, are substantially the same in Kittle and in Ellis?

A. They are.

Q. What pressures do you find mentioned in the Kittle patent?

A. In the translation, page 5, I find the statement:

"With the object of insuring the conversion of the hydrocarbons into more volatile hydrocarbons, the oil is maintained at an elevated pressure, while it passes through the apparatus."

Q. Referring to page 2 of the original French specification in the Kittle patent, second column, about the middle of the column, what do you find in regard to the pressures employed?

A. That they were 6.45 kilograms per square centimeters, which would be approximately 6½ atmosphere pressure, or 95 pounds per square inch. That is on page 2, line 82.

Q. Please state whether or not, to your knowledge, the art, prior to 1920, and particularly prior to November 26, 1918, contained any disclosure of the process of making gasolene substitute, which comprises passing kerosene, or heavier oil, through a heated zone, wherein the oil is brought to a decomposing temperature, in a single passage, and passing the products at a slower rate through an enlarged passageway, without increasing their temperature, or without permitting the temperature to drop below the decomposing temperature, and maintaining super-atmospheric pressure on the oil, in its passage through the heated zone and the enlarged passageway.

Mr. Wiles: May I inquire why that question is limited to that particular date?

Mr. Rauber: The Ellis patent was filed in 1920, and any art that is prior to the date of filing, may be pertinent.

A. Schuchow & Gavrilow, in Russian Patent No. 4,782, in 1892, describes such a process.

[fol. 201] Cler-q, German Patent No. 166,723, of January 10, 1906—I am mistaken about that. This doesn't do it, because it is a tar mixture, and not a kerosene oil, or heavier oil.

Kittle, French patent, No. 417,532, November 16, 1910, describes such a process.

Pielsticker, British patent, No. 1,308, of 1891, describes such a process.

Also, Pielsticker, United States patent No. 477,153, of June 14th, 1892, describes such a process.

Q. In the Kittle patent, from what do you judge that the temperature in the tank is not permitted to drop below a decomposing temperature?

A. Because the tank is surrounded by the same lead bath, or other molten metal bath, as are the cracking tubes.

Q. Do you understand that those tubes in Kittle, are at decomposing temperature?

A. I do.

Q. Is it your understanding that the cracking is completed in those tubes before the liquid enters the tank?

A. No. I would expect that there would be some cracking while it was in the tank.

Q. From what do you judge that the Pielsticker tank does not fall materially below the temperature of the cracking tubes?

A. Because it is heated by essentially the same kind of a furnace as the tubes, themselves.

Q. You stated that the Schuchow patent disclosed an apparatus in which the tank was permitted to drop below a decomposing temperature. On what do you base this opinion?

A. On the fact that the bottom of the tank A is heated by the furnace, and, accordingly, it should be approximately at the same temperature as the tubes, which are concerned, primarily, with the cracking of the oil.

Q. Will you compare the arrangement of the tubes in the Schuchow, et al. apparatus with that of the Ellis patent, No. 1,145,232?

A. In the Ellis patent the tubes are essentially horizontal—they are nearly horizontal. Whereas, in the Schuchow, et al., patent, the tubes are either coils, or, as he expresses it, "May be groups of straight pipes", which I would understand to be vertical pipes, though it might possibly be an arrangement similar to that of Ellis—that is, a group [fol. 202] of horizontal pipes. But probably it would be a group of straight pipes.

The tank, in Ellis, is above the tubes, and heated by the furnace, and the same thing is true of the Schuchow et al. tanks. The upper portion of the tank of the Schchow, et al., patent, is exposed to the air, where it is not, in the case of the Ellis apparatus.

Q. In the Schechow, et al., apparatus, would there be less likelihood of over-heating the drum, A, than in the Ellis drum, A?

A. Yes, because there is cooling of the upper part of the tank, by means of its exposure to the air.

Q. From your reading of the Schuchow, et al., specifications, do you understand that the oil might be passed through those tubes, small *d*, but once, into the drum, A?

A. Page 2 of the translation of the Russian Schuchow, et al., patent, reads—beginning on line 1:

"According to the speed of the liquid's circulation in the pipes, and depending upon the purpose of the distillation, the liquid settling in cylinder, A, is drawn through pipe D, and tap A, so as not to undergo further distillation, or by means of valve Q, it is caused to enter the pump once more where it is mixed with a fresh supply of liquid flowing to the pump, and returned for further circulation to the coil tubes."

In other words, it can be operated in either way.

Q. In any of the prior art disclosures that you have mentioned, that is, the Schochow, et al., patent, the Kettle or the Pielsticker patent—does any substantial cracking of the oil take place in the long passage way or tube, and further conversion or digestion take place in the large passage-way?

A. Such cracking does take place in the tubes, and there is an opportunity for digestion in the enlarged portions or passage-ways, or tanks.

Q. What is the temperature used in the Kittle process, as diclosed in the French patent to Kittle, No. 417,532, Petitioner's "Exhibit No. 131?"

A. About 700 degrees Centigrade, which would mean 1,292 degrees Fahrenheit for the moulten lead bath. The contents of the tubes, of course, would be at considerable temperatures below this.

Q. What is the temperature of the tube content, as given in the specification of the Kittle patent?

A. The statement is made on the bottom of page 2 of the translation:

"Because of the absorption of heat by the oil, the tem- [fol. 203] perature of the latter will ordinarily be about 500 deegres C.,"

which would mean 932 degrees F.

Q. How does this temperatrue compare with those specified in the specification of Ellis Patent, No. 1,415,232?

A. He states that the temperatures would vary, for example, in Column 1, page 1, line 38: "A decomposing

temperature of 400 to 600 degrees C." This 500 degrees of Kittle is exactly midway between the temperature limits given by Ellis.

Q. As far as temperature conditions are concerned, you would consider the conditions of Kittle to be the same as those of Ellis, would you?

A. Yes, sir.

Q. In the disclosures of the art, prior to 1918, do you find any disclosure of the practice of separating gasolene hydrocarbons from the heavy hydrocarbons, and rerunning the separated hydrocarbons through the cracking process?

A. I do find such statements in the disclosures, of dates earlier than that indicated.

Barbet, French patent, No. 380,282, of October 2, 1907, cracks and then re-runs the liquid not cracked by first passage.

The Master: Isn't that what is practically done in a continuous still?

The Witness: Yes and no. There is some cracking going on during the process of distillation, and, as I understand the question, the question was related to cracking and a complete removal of the gasoline, and then taking the product which contained practically no gasoline, and then rerunning it through the cracking still.

The Master: And the object of that was accomplished by what is known as the continuous process of returning the heavier products to the tank, and continuing the distillation on up?

The Witness: Yes, and no. It is more than the cracking of the run-back product,—it is the cracking of the residue, which has never been volitalized. Whereas, in the case you refer to, I understand was simply a question of the cracking of the run-back material.

I do not see it in the text, but in the figure, the product which has passed through the cracking still, and from which the vapors have passed upward into the still head, N, and from that into the valve and through the valve and into the condenser—I am reading, now, from Fig. 2—and the residue passes downward through *h*, the cracking still, into the receiver at the bottom of this cracking still, and passes through the siphon, G', and is carried up by the steam jet, S, to the top of the apparatus, and injected, thereby, again,

into F, to pass down the still the second time—this being a vertical still.

Testelin and Renard, British patent, No. 16,881, of 1908, states on page 2, line 11:

"By passing the heavy products through the apparatus again, they are finally transformed into light spirit."

This refers to the product which has passed through the cracking still, which, in this case, is of vapor type, and has been distilled in a separate apparatus, b^1, b^2, and condensed in the final condensation taking place in the appatus C, and the residue drawn off from the drum A, and passed back for redistillation.

[fol. 204] The Master: In that process would you understand that the stock operated upon originally was crude petroleum?

The Witness: He does not limit it, necessarily, to crude petroleum. On page 1, line 5:

"This invention relates to the manufacture of spirit by the treatment of petroleum."

But it does not say that it cannot be a product from which the gasoline, or kerosene has been distilled, or even a gas oil.

I would say that he had in mind—that probably he had in mind the materials that are customarily used for cracking, which are the heavy products, that is, after the kerosene and gasoline is distilled off, as well as crude petroleum of the heavier types.

In the process which I have just previously described, of Testelin and Renard, the cracking is carried out under pressure.

In the case of Noad, British patent, No. 13,675, of 1908, we have a process carried out of atmospheric pressure, and the residue, it is stated, can be retreated. I read from line 315, page 1, of this British patent.

"The residue from the rectifying still, and any heavy products that might have been condensed and not rectified, may be returned to the re-action chamber for retreatment."

In the corresponding United States patent of Noad, United States patent, No. 971,468, of September 27, 1910,

we have this same process of cracking in horizontal tube retorts, at atmospheric pressure—at least, not at a high pressure—and a suggestion that the residual oil can be re-run. I read from line 60, page 1, of the United States patent:

"The residue from the rectifying still, and any heavy products that may have been condensed, and not rectified, may be returned to the reaction chamber for retreatment."

In the article by Oglobin, Zeitschrift fur Angewandt et Chemie, of 1904, page 546, Petitioner's "Exhibit No. 148"—I wish to correct that year as 1905 instead of 1904—he cracks Russian oils, and the distillation product is fractioned, and product boiling above 200 degrees is again subjected to decomposition under pressure. This is re-running of the product, which might be spoken of as a residue, or as a distillate. It is a distillate, but it is a second running of the product.

Engler Deutschen Chemischen Gesellshaft Vol. 21, pages 1816 to 1827, of 1888—Petitioner's "Exhibit No. 99—mentions, in the latter part of the fourth paragraph, the re-dis-[fol. 205] tilling of the product which had not decomposed, this distillation and the original distillation being at a pressure of about four to ten atmospheres.

Q. In one of your immediately preceding answers, I understood you to say that the reflux condensate was not quite the same as one obtained from atmospheric pressure distillation, because the reflux would come in contact with other oil being distilled. Would that reflux condensate returning to the still, be the same as an atmospheric pressure distillate of a cracking residue mixed with fresh oil and returned to the still?

A. Probably not. The reflux distillate would, in the first place, be of lower boiling point than the residue left in the still. It would carry still more of the lower boiling point materials, because it has been in contact with the gasoline-like vapors, passing in the reverse direction. That residue would not be the same as the pressure distillate mixed with fresh oil and returned to the still, but would approach it, in that it would carry some of the volatile constituents. The biggest difference between the return distillate of the reflux, and the residue oil left in the still, or the distillate

from the residue oil left in the still by atmospheric distillation, is the difference in boiling point, the residue having a much higher boiling point, and a correspondingly higher density.

Q. But if you obtain a distillate from the pressure residue, of the same boiling point, would it be approximately the same in character, as the reflux, or run-back?

A. Yes.

Q. Will you please compare the heating arrangements of the Russian patent, the Schuchow, et al., patent, No. 4,782, [fol. 206] "Petitioner's Exhibit No. 129"—with the heating arrangement disclosed in Adams Patent, No. 1,320,354?

A. In the Adams Patent, No. 1,320,354, of October 28, 1919, we have, as a heating arrangement, an internal heater separate from the walls of the vessel, heated by electricity, and, in general, heated to incandescence.

In the Schuchow & Gavrilow patent, Russian Patent No. 4,782, of 1892; "Petitioner's Exhibit No. 129,"—we have a series of coils, or straight pipes, heated by a furnace with ordinary types of fuel, this heating being external to the coil, or straight pipe retort used, and there is no internally supplied heater separate from the walls of the retort.

I can not tell from the description of the patent, or from the drawing, as to whether it is coal, fuel oil, or gas that is used for heating, but the fuel box resembles more a coal fire box than either of the other two.

Q. Aside from the form of the coils and of the electric heater, is the arrangement substantially the same in the Schuchow, et al., patent and the Adams device? That is, the arrangement of heating portions to the receiving drum?

A. Yes. There is, in the Adams patent, a somewhat smaller length of—comparatively smaller length of retort, but the essential elements consisting of the retort, receiving drum, a scheme for return of the uncracked portion, a scheme for distilling off the vapors—are essentially the same in the two disclosures.

Q. How do the heating arrangements of the Adams device and of the Schuchow, et al., device, compare with those of the apparatus shown in the Ellis patent, No. 1,415,232?

A. The scheme used in the Ellis patent, No. 1,415,232, of May 9, 1922, for heating the approximately horizontal straight pipe, is essentially the same as that disclosed in the Schuchow & Gavrilow Russian patent,—that is, we are heat-

ing, in this case, by any suitable means, as Ellis says—for example, by fuel gas supplied through the pipe, 2, and the flame from this fuel would be in approximate contact with the cracking still, as is the case in the flame from the fuel in the cracking still of Schuchow & Gavrilow.

Q. In your opinion does the Schuchow, et al., device resemble Ellis, more than the Adams device does?

A. Yes.

Q. Will you please compare the heating arrangements in the French patent to Kittle, No. 417,532, "Petitioner's Exhibit No. 131," with the Ellis and Adams heating devices—[fol. 207] that is, the heating devices of the Ellis patent, No. 1,415,232, and the Adams patent, No. 1,320,354?

A. In the Kittle patent, the French patent, No. 417,532, of November 16, 1910, "Petitioner's Exhibit No. 131," we have a coil and tank within a large metal bath, and between the two a bath of molten metal—say molten lead—the whole being heated by a series of flames of the vaporized product being heated by a series of flames of the vaporized product obtained by the cracking of the petroleum.

In the case of Ellis we have the heating of the cracking tubes direct, by the flame. Whereas, in the case of Kittle, there is an intermediate material—that is, molten lead, or other metal,—which serves to make uniform the heating of the coils, rather than a case where the coils might be heated locally by the gas burners.

The gas burners applied by Kittle are outside of the vessel holding the molten lead.

The gas burners of Ellis are inside the general container, just below the straight tube retort used for cracking.

In the case of Adams, patent No. 1,320,354, of October 28th, 1919, we have neither a supply of heat by the burning gas or oil, nor do we have, as in Kittle, a supply of molten lead, as a scheme for making uniform the heating of the coil. Instead, we have an incandescent electric heater, separate from the walls of the pipe-like retort, which heater supplies the heat needed for the cracking process.

Q. In your preceding answer you stated that the burners were within the general container—by general container, do you mean the furnace?

A. Within the outside walls of the furnace—not within the retorts.

Q. Which heating arrangement do you consider to resemble Ellis, more closely—the Kittle, or the Adams?

A. Kittle, very much so.

Q. In the specification of the Kittle patent, do you find anything that would indicate that the cracking, or breaking up of the hydrocarbon molecules was completed before they left the coil?

A. We find on page 3 of the French citation, in the last paragraph, first column, a statement to that effect. Its translation reads as follows:

"It results from this that the heat is used in producing the chemical transformation of heavy hydrocarbons into light hydrocarbons. A certain point is reached during the passage of the vapor through the worm, at which each sub-
[fol. 208] sequent heating would produce a constant rise of temperature, which indicates that the chemical transformation is finished."

"It is this point in the apparatus that determines the length of the worm, before being immersed in the molten metal—given that the vapor ought not to be heated beyond this point. It is then immediately led into the condenser."

Q. Do you understand that the tank F, of the Kittle device, is kept at approximately the same temperature as that of the coils?

A. It would be kept very close to the same temperature as that of the coil, because they are both surrounded by the same molten lead bath, and as such, the bath would not vary very much in temperature at the different parts of it.

Q. In your opinion, would there be an opportunity for the cracked products to digest in this tank, F?

A. There would be some opportunity. This tank, F, is not very large, so that the period of time would be only moderate in extent. But there would be some digestion there. That is, it is a place where their velocity is decreased, and they become relatively quiet in their movement.

Q. How does this disclosure compare with that of the Ellis patent, No. 1,415,232?

A. It is essentially the same—that is, in the Ellis patent, you have a passage of the cracked products into the chamber 8, and a digesting there, for a brief period of time, be-

fore passing on to the other parts of the apparatus, through the pipe 9.

Q. Will you please state, whether or not, to your knowledge, the art, prior to 1909, contained any disclosures of an apparatus comprising a retort embodying a pipe-like section, means for locally heating the oil in said pipe-like section, to a cracking temperature, means for continually forcing oil into such sections under pressure?

A. The Kittle citation which I have just been discussing, being Petitioner's Exhibit 131 of date of November 6, 1910—this will not apply because it is 1910 instead of 1909.

The Russian patent Schuchow & Gavrilow 4782 of 1891, being Petitioner's Exhibit 129, meets the conditions of your question; the pipes D being the pipe-like structure used for cracking, the pump B forcing through the pipe C oil to the cracking still, and in every other respect it meets the conditions of your question.

The French Patent No. 380,282, to Barbet, of October 4, 1907, which is mentioned in the patent as being an improve-
[fol. 209] ment on Barbet's French Patent No. 328,265, where pressures of 5 to 6 atmospheres are mentioned, gives a pipe-like structure, H, into which oil is forced by means of a steam siphon and this process can be operated under pressure as it is an improvement on the French patent mentioned. It meets, I believe, all of the requirements of your question.

Q. In that Barbet patent that you have just mentioned, was that steam siphon for the purpose of forcing in the oil or for circulating it?

A. It is for the purpose of lifting the oil from the vessel G and putting it into the vessel F, which is the feeding vessel of the retort.

Q. Is there another supply aside from the steam jet for forcing the oil into the cracking apparatus; is there a supply pipe?

A. There is an additional supply of oil besides this one which I just mentioned. It is stated in the text as translated:

"From the boiler the liquid to be disassociated passes to one or the other of the disassociaters in a continuous manner through the siphon 2-B and the valves R, R prime."

This would be from the tank or boiler M, which is a supply boiler.

In the French patent to Barbet, addition 8213 to Patent No. 322,265, which addition was published in February, 1908, and which is Petitioner's Exhibit 125, we have a pipe like cracking still shown in the figure attached to the patent as H, fed by supply of oil at F, which supply reaches it partly from the supply tank through the pipe D and valve R, and partly from the pipe G to which is attached a steam siphon, S, both feeding into the top of the retort of pipe-like character, G.

This would also meet the conditions of your question.

Q. Do you find in any of these apparatus of Schuchow or Barbet anything in the nature of a vapor dome or collecting chamber?

A. Yes. In the Barbet patent, No. 8213, which is an addition to an earlier patent of Barbet, and which is Petitioner's "Exhibit No. 125," we have the vessel, F, together with the gooseneck, N, passing away from this vessel, serving as such a vapor dome.

In the Barbet patent, No. 380,282, Petitioner's Exhibit Nos. 124," we have the same kind of apparatus described and the same kind of a vapor dome, and indeed, with the same lettering.

[fol. 210] In the Schuchow citation, being Petitioner's "Exhibit No. 129," Russian patent, No. 4782 of 1891, we have the dome A, and the smaller dome surmounting it, serving in the same way as a vapor dome.

Q. In any of the apparatuses that you have mentioned, Schuchow or Barbet, is the oil caused to pass or flow from a source of supply in a confined liquid stream, restricted in cross section, heated under pressure to a cracking temperature and low boiling products obtained as a result of said heating?

A. The process you describe is true of Schuchow and in the two Barbet patents which have just been discussed.

Q. Have you read and do you understand the disclosures of Adams' patent, No. 1,320,726?

A. I have read it and I understand it.

Q. What do you consider the most characteristic feature of this Adams' patent?

A. The most characteristic feature is probably the use or the running of a heavy oil on to a hot plate, either of solid metal or of fused metal for the purpose of cracking.

Q. Does the oil in immediate contact with this plate form a part of the main body of oil, or is it separated to some extent from the main body?

A. It is separated to a partial degree, there being, however, a fairly good sized neck of oil connecting it with the main body in the converter.

Q. Referring to the United States Patent to Man, No. 619,593, Petitioner's "Exhibit No. 143," do you find the use of a heated plate in this patent?

A. I do.

Q. What is the number of the plate?

A. This is in figure 1, the plate A, which is fed with oil through the pipe B. This plate A is heated by superheated steam or by a furnace beneath. In the description it is spoken of as a cup A, due to the fact that it slopes upward toward the center. There is above it a body of oil which is of narrow height and which is connected by a small body of oil with the bulk of the oil contained in the converter.

Q. Will you please state whether or not to your knowledge the art prior to December 31st, 1914 disclosed a process of converting high boiling point hydrocarbons and the low boiling point products which consists in confining a body of [fol. 211] oil within inclosed containers, subjecting a portion of said oil below the surface to a local cracking and converting temperature in excess of its volatilizing point; continuously introducing oil into said body at the point where where it is subjected to the local cracking temperature at a rate greater than that at which the oil is converted, withdrawing the oil from the upper part of said body at such a rate as to maintain constant volume and level of oil and condensing the converted vapors?

A. Schuchow and Gavrilow, Russian patent, No. 4782 of 1891, being Petitioner's "Exhibit No. 129," describes such a process, the oil being forced into the heated oil retorts or straight pipe retort by pump B, withdrawn from the dome A, by the pipe D, and being, with new oil, sent back to the retort, the gasoline-like vapors passing through the upper part of the dome N, and the valve M, to the condenser.

In Pielsticker's British patent, No. 1,308, of 1891, being Petitioner's "Exhibit No. 133," we have a similar feeding

by a positive pressure pump C, of oil, which has been heated in the tank, A, to a series of cracking coils, D, in the furnace illustrated in Fig. 1.

It is further cracked in the retort L and the gasoline like products passed out through the valve R to the condenser; residues being drawn off through the cock, N.

In the United States Patent to Pielsticker, Patent No. 477,153 of June 14, 1892, Petitioner's Exhibit 134, we have the description essentially the same as in the British patent which I have last discussed, the pump C supplying heated oil to the furnace, Fig. 1, and the products from this cracking coil passing over into the cracking vessel, N, where it is further cracked, the gasoline like products passing out through the dome R and valve *b* to the condenser; the residual products passing out through the cock P.

In the French patent to Kittle No. 417,532 of November 6, 1910, being Petitioner's Exhibit 131, we have the oil cracked in the coil B, the vapors and uncracked portions passing to the small tank F, the vapors or gasoline products passing through the pipe F and the valve indicated but without a letter to the condenser G for condensing them into liquid, gasoline like products. The residual products passing out from F into tank K are returned by pump L to the supply tank A, which is under pressure and fed from it by a pipe through the valve A^1 to the coil for retreatment.

In Clark's Patent No. 1,119,496 of December 1, 1914, we have the passing of the oil from the supply tank 1, through [fol. 212] the pipe 2 and the pump 3 to the cracking coils 4, in the furnace 5, and out therefrom by the pipe 6 back to the tank 1, and from there the hot gasoline like products, in the form of vapors, pass by pipe 7 to the condenser 8 and are cooled. The residual hot oil being returned for retreatment through the pipe 2, pump 3 and so forth.

Each of these gives the process which you have mentioned.

Q. Do any of the processes which you have mentioned operate under pressure?

A. All of them.

Q. What difference would it make, if any, in the manner of heating; that is, of passing heat into the pipes, whether the condensation of the product takes place under pressure or whether the pressure released between the tank and the condenser?

A. It would not make any difference, provided the valve between the condenser and the still was one which operated evenly and efficiently.

Q. Do any of the processes disclosed in the art that you have just mentioned actually condense under pressure?

A. Yes. The Clark Patent No. 1,119,496 is one which condenses under pressure.

Q. Will you please compare what you consider to be the characteristic features of Adams Patent No. 1,320,726, and Adams Patent No. 1,320,254?

A. In the Adams Patent No. 1,320,354 the characteristic feature is the use of the electrical heating, the preferred heating unit being an electrical heating unit separable and inside the walls of the retort.

In the Adams Patent No. 1,320,726 the characteristic item is the heating or the cracking of the oil by bringing it into contact with the hot metallic plate.

Q. In your previous testimony of October 26th you mentioned the production of carbon in the cracking of hydrocarbons and similar materials. In what form does the carbon thus produced appear in the still and what effect does it have on the heating of the oil?

A. It appears in the still in two forms, one, as suspended particles of carbon, and in the second form (and it is this second form that gives particular trouble in the still) as an adherent carbon coating on the surface of the heated walls of the retore.

Q. Does carbon ever appear in this form in any other [fol. 213] hydrocarbon liquids such as coal tar subjected to distillation?

A. It does. The troubles are essentially the same whether it is a cracking process using petroleum or a process making gas by cracking procedure, such as ordinary coal tar is made.

Q. Well, does this carbon ever occur in the distillation of the coal tar already made?

A. Yes. You will have the original carbon in the part w-ich is suspended, adding to the carbon which is formed during the distillation of the coal tar, due to the cracking of portions of the coal tar. This carbon which is formed there, to a large extent, adheres to the walls of the retort and thereby coats the wall of the retort and prevents heat transfer through the wall of the retort.

Q. You mean it increases resistance to the transfer of heat through the walls?

A. Yes, in every case—in both cases. This resistance increases very rapidly as the conductance of heat by a metal is very much greater than the conductance of heat by an equal thickness of carbon or other scale-like materials of non-metallic character.

Q. Is the action of the carbon or coke thus produced the same in the case of distillation under pressure as it is at atmospheric pressure?

A. There is no essential difference between the two.

Q. Do you know of any disclosures in the art prior to 1909 for avoiding or removing such deposits of carbon when distilling hydrocarbon liquids? I have reference to either atmospheric or pressure distillations.

A. In the Russian patent to Intschick, No. 4,584 of 1890, which I think is Petitioner's Exhibit 120, we have such schemes for removing carbon described. In Fig. 9, and similarly in Fig. 11, also in Fig. 10, we have illustrated chains carrying iron balls. It is also described in the translation (I read from page 8 of my typewritten translation, line 2):

"A device is constructed consisting of cast iron balls, pp. (Figs. 9, 10 and 11) connected by chains to one another and to the bar P prime, which by its head, P^2, is attached to the distributing apparatus (Fig. 16).

Should the bar be turned 90 degrees about its axis it head will get off the shoulders, FF, and pass freely downward through the cutouts, F^2, F^2. In each case the bar with the whole balls will of course also come down. On the inside the walls of the retort are provided with several vein-like [fol. 214] furrowa running the whole length of the retort in the form of a spiral cut (lightening) from three to four turns."

Such a scheme will, with its movement of a chain and ball, serve for aiding in the removal of carbon though it is not described here for that particular purpose.

We have in the third paragraph following, this entire paragraph of importance:

"Although there is no coat forming or asphalt incrustation in the retort there is formed a very fine dust (microscopic particles of carbon) settling inside on the walls of

the retort in the form of down; which, due to their insignificant weight are immaterial as to the loss of material but (settling on the walls) lower the heat transmitting qualities of the retort, hence in case of continuous running it is necessary to clean off this layer once or twice in 24 hours. For this purpose the stopper Y (Fig. 16) is screwed out of the covered retort. Through the opening thus formed the reservoir K is taken out and upon the thread of the bar, P', a stem is screwed on by means of which the balls and chains are lowered and the soot is knocked off. For a more thorough cleaning wire discs in the form of brushes are placed on the chains."

Such brushes on the chains, or the use of the balls and chains themselves would be schemes for the removal of the carbon from the inside of a retort.

Q. Do you find any mention of pressure in this Intschick specification?

A. Yes, for example in the translation, second paragraph, on page 6:

"The gas entering under pressure which passes in the retort through the tube A," accordingly, there is mention or pressure.

Q. Referring to Warden Patent No. 110,806, Petitioner's Exhibit 126, what is the purpose of the still described in this Warden patent?

A. It is essentially a still for the straight distillation of petroleum, though it may be used from other materials, and is so arranged that the heavy tar residue containing carbon may be drawn off at a point below the heating zone.

Q. What type of retort or still is it?

A. It is a pipe-like retort heated in its intermediate portion.

Q. What is the purpose of this pipe-like vertical retort?

A. To carry out a continuous distillation and to economize [fol. 215] in fuel by using certain types of heat transfer apparatus with the idea of distilling off the lighter portions of the material being treated and accompanied by some cracking.

Q. What advantage does this type of still have. or is stated to have in the Warden patent in preventing the formation of carbon deposits on the wall of the still?

A. This is best stated in the patentee's own words, page 2, third paragraph of the second column (the lines are not numbered in this early patent of 1871) reads:

"Another important feature of my invention is the application of heat to the vertical parts of the still which thus afford lodgement for the heavier matters so that incrustation is prevented and the efficiency of the entire heated surface of the still is maintained."

On page 1, second paragraph of the second column, he speaks of the lower portion of the still:

"Being a receptacle for the retention of the residium, which, being free from exposure to direct heat, cannot become incrusted but may be drawn off in fluid or semi-fluid state through the pipe *n* when the still is being cleansed."

On page 2, about line 9:

"One of the most important features of my invention is the peculiar arrangement of the still within the heating chamber of a furnace * * * an arrangement which tends to preserve the still and lessons the consumption of fuel. While that portion of the still beneath the point where the fire is applied affords a receptacle below the fire of such size as to retain all of the heavier particles from which volatile matters have been removed—"

Q. You understand the purpose to be then to collect the carbon dropping out of the heafel portion of the still?

A. Yes, and to keep the heated portion as clean as possible.

Q. Do you find any similar arrangement in the patent to Lennard No. 6,509,076, Petitioner's Exhibit 121?

A. We have in the Lennard Patent No. 6,509,076, a similar disclosure where a tar mixture diluted with naphtha is distilled; carbon remains back in the retort B and is removed from the walls of the retort B by a rotating scraper *b*. In such a case the carbon is scraped off and falls down into the lower part of the vessel and is removed at the bottom at the point indicated in the Fig. 1 by b^3.

Q. Would the carbon removal features operate the same in the Lennard and Warden patents whether operated un-

[fol. 216] der pessure, or that is, at pressures above atmospheric or at atmospheric pressure?

A. It would make no difference whether the operations were carried on under pressure or at atmospheric pressure.

Q. That is, so far as the dropping of the carbon is concerned?

A. Yes, so far as the removal of the carbon from the surface of the retort and dropping it to the bottom.

Q. Do you find any arrangements in the British patent to Gaster, No. 6,739 of 1901 for the removal of carbon?

A. I do. In Fig. 1 we have such an arrangement indicated, and it is described in the specification, page 7, line 19:

"The retort is provided with a stirer, chiefly consisting of a vertical shaft, 3, provided with radial arms, 4, carrying the blades, or scrapers, 5, through the intermediary, and a hinged piece, 6, Fig. 8."

In Fig. 8 we have details of the type of scraper and there is indicated the kind of adjustment for wear.

On page 7, line 40, we have a discussion of the importance of the scraper:

"As the heating capacity of the retort for the extraction of the free carbon depends partly on the motion of the scraper for keeping the sides or the retort clean, the supply of the mixture to the retort should be regulated automatically, which may be effected by a regulating tap, 15—Figs. 3 and 4—controlled by a centrifugal governor, 16, or other means adopted to stop the supply of the mixture when the scraper stops, and, thereby, to avoid the clogging of the powdered free carbon."

And in the last line on page 7:

"The scraper must be capable of easy adjustment, so as to compensate for expansion and contraction caused by differences of temperature, and also for the wear and tear of the blades."

And we have in the next two paragraphs a discussion of the construction of the scraper. In the line 18, the following statement discusses what is done with the carbon after the scraper has removed it from the walls. It reads:

"The carbon scraped off the walls of the retort, 1, drops into the intermediate chamber, 23, provided with a sliding door at the top and one at the bottom—not shown—which doors may be mechanically connected in such a manner that one of them must always be closed before the other can be opened, so as to prevent the access of air to the retort."

[fol. 217] Q. In the Adams patent, No. 1,327,263, do you recognize a disclosure of any means for removing carbon from the still? And if so, will you compare it with the carbon removal means art you have just described?

A. I find described in Adams patent, No. 1,327,263, a scheme for removal of carbon from the interior surfaces of the cracking chambers, 12, as shown in Fig. 2.

I read from page 4, line 71, which follows a discussion of the revolving core cylinder:

"Another specific function of the helical collar, 69, when in rotation, is to remove and throw down the accumulation of scales and particles of carbon and coke which may adhere to the interior surface of the cracking chamber, 12."

Referring, now, to Fig. 2, we find that this helical collar is on a shaft, 23, and rotated by gears, 36 and 35.

On page 3, line 2, I quote:

"At the lower part of the converter, B, and connected to chamber, 12, heavy bottoms and residue chambers, 30, are arranged to collect the precipitated carbons and fallen substances thrown down by this converting process, and near to the lower end, a suitable door or outlet pipe, 18, may be provided and controlled by the valve, 19, shown in Fig. 1 and Fig. 2."

Accordingly, we have here in this Adams patent, a disclosure of the same essential elements as have the other types of scrapers described in the citations which I have just discussed.

We have, in this case, as in the other cases, a scraping element, which, in this case—in the case of Adams—a scraping element, 69, and a chamber for the particles scraped off, to fall into, which is chamber, 30.

The Master: That chamber 30 is filled with heavier oil, isn't it?

The Witness: Yes, and particles of carbon and coke and dirt. It would be granular to the fingers like the bottom material of a coal bin.

Q. How does this structure of Adams compare specifically with that of Leonard, patent No. 659,076?

A. It is essentially the same. We have a scraper working in B and the products dropping down into a chamber beneath B^3, and being taken out through an opening at the bottom of this residue chamber, below the scraper.

The Master: They are both revolving scrapers?

The Witness: Yes, sir.

[fol. 218] Q. Will you also compare the Adams' structure with that of the British patent to Gaster, No. 6,739, of 1901, "Petitioner's Exhibit No. 127"?

A. We have in the Gaster patent, figure and specification, the scraper, 5, which works on the walls of the retort and drops the residue down into chamber, 23, from which it is removed at a later time. This is also a rotary scraper, working in the retort, 1, as shown in detail, in Fig. 8.

The Master: Shown in cross section?

The Witness: Yes, sir, shown in cross section in Fig. 8. The general assembly being shown in Fig. 1, together with the chambers, 23, and 24.

Q. How does the Adams still compare with that of the Barbet, French patent, No. 380,282, "Petitioner's Exhibit No. 124" in regard to the shape of the still and permitting carbon to fall therethrough?

A. The shape of the still is essentially the same as in the case of Adams, excepting that the tank at the bottom, in the case of Barbet, is enlarged, instead of being essentially the same diameter as the still, itself. In other words, the still portion is essentially the same, both being pipe-like structures, and heated only in the space of the narrow pipe portion of the assembly.

Q. How does the apparatus of the Adams patent compare with that of the Russian patent, Intschick, No. 4,584, or 220 of 1890, "Petitioner's Exhibit No. 120"?

A. Both use the same general type of pipe-like retort, though of course, Adams method of heating by electrical resistance unit, is not used in the Intschick patent. The Intschick patent also has a receiving vessel at the bottom of a pipe-like retort which takes care of residue and precipitated carbons and it also has a scheme of removing the carbon from the walls of the pipe-like retort, as does Adams. The scheme, however, is not the same in the two cases, one being a rotating collar and the other being a scheme of brushes or balls attached to a chain.

Q. In each case, that is, in the Intschick, and also in the Adams patent, is the carbon permitted to fall out of the heating zone?

A. It falls into a chamber at the bottom, below the heating zone.

Q. Will you please state whether or not to your knowledge the art prior to 1911 disclosed a process of treating hydrocarbons to obtain lower boiling point hydrocarbons, [fol. 219] which consists in continuously supplying the high boiling point hydrocarbons to a closed chamber to maintain a proper supply therein, and subjecting the high boiling point hydrocarbons to a cracking temperature in said closed chamber or pipe-like heater under pressure, removing carbon from the heated portion of said heated chamber or pipe-like heater and passing the vapors evolved through communications to a condenser?

A. We have in the Intschick Russian patent, No. 4,584 of 1890 such a process disclosed in which the various steps you mentioned are carried out.

In the Lennard United States patent, No. 659,076, same being Petitioner's Exhibit No. 121, you have the same process as you have described, excepting that it is not working under pressure.

The Master: Under the Lennard patent wording, would it be capable of working under pressure?

The Witness: Yes, if you put pressure on the feed tank and a valve at the end of the condenser. That is, the liquid would have to be fed in under pressure or pumped in and the valve placed at the end of the condenser or between the condenser and the still.

Mr. Rauber: I wish to offer in evidence, as "Petitioner's Exhibits Nos. 226, 227, 228, 229 and 230", the following named patents:

Dubbs, 1,123,502, Jan. 5, 1925;
Parker, 1,226,990, May 22, 1917;
Holmes, 1,241,979, Oct. 2, 1917;
British patent to Von Groeling, 10,213 of 1913;
British patent to Laing, 23,446, of 1911.

The said patents, so offered, were admitted in evidence, were marked respectively:

"Exhibits Nos. 226, 227, 228, 229 and 230", and the same are herewith returned.

Q. Referring to the Adams patent, No. 1,327,263, do you consider this retort to be especially well adapted for withstanding heavy pressures? I call your attention particularly to the cover plate, 21.

A. For an apparatus to be used under pressure, we should not use flat walls, such as plate 21. Such walls will ordinarily bend and give trouble when used as a part of a vessel under pressure.

The Master: That is the closing top of the digester, there?

The Witness: Yes, sir, but it is flat, and a thin flat plate is not good.

The Master: Instead of dome shaped?

The Witness: A dome shape will stand up much better.

Q. How does the cover used in the Lennard patent, compare with——

The Master: Now, this is diagram-atic—how do you know that he doesn't use a dome-shaped plate?

The Witness: I think the answer to that is really that in his original specification, he was discussing the use of slight pressure. My feeling is that his diagram, as made, is perfectly adequate to the type of process which he was carrying on, as described in his original specification, but not as that which he afterwards amended and brought in higher pressures.

Q. How does the Lennard patent compare in this respect—Lennard patent, No. 659,076—"Petitioner's Exhibit No. 121"?

A. The Lennard is a dome shaped cover, such as is customarily used for moderate pressures.

Q. Your conclusion, then, would be that the structure of Lennard would be as fully well adapted for pressures, as that of Adams?

A. Absolutely, fully as well—in fact, better adapted for pressure.

Q. That is, assuming that the bottom of the Lennard still is closed?

[fol. 220] The bottom of the Lennard still is given as a pipe, C, page 1, line 77, and as such the presumption is that this pipe could be easily closed at the other end. I was referring particularly, however, to the top of the still.

Q. Will you please state whether, to your knowledge, the art, prior to 1911, disclosed a process of treating high boiling hydrocarbons to obtain lower boiling point hydrocarbons. which consist in continuously supplying the high boiling point hydrocarbons to a closed chamber, subjecting the high boiling hydrocarbons to a cracking temperature, under pressure, removing carbons from the heated portions of said heated chamber, and passing the vapors evolved through a connection to a condenser, all in open communication, so as to insure a substantially uniform pressure from the heater to the condenser?

A. If the Dewar and Redwood, United States patent, No. 419,931, of 1890, is taken, and the method of using the apparatus continuously, as indicated on page 2, be chosen, then we will have the continuous introduction of liquid through pipe, E-1, to this pipelike still, illustrated in Fig. 1 of this patent, a cracking of the oil in this still, a removal of the carbon, which will be suspended in the cracked residue, through the pipe, E-2, and the vapors from this will be passed, at the same pressure, to the condenser, D, and there be condensed and passed into the receiver, D-2, all under pressure.

This would meet the process you have mentioned, and it is of 1890, which is well before the 1911 date that you suggest.

The same process is described in Redwood's Treatise on Petroleum, First Edition, 1896, Volume I, pages 320 to 322. The same figure is given as the upper part of Fig. 100, with

the same lettering, so that the description which I gave from the Dewar and Redwood, United States patent, applies to this English publication of 1896, without change, and, accordingly, meets the conditions of the process which you have described.

Another reference which describes the process which you have given, is Laing, Transactions of the Royal Scottish Societies, Volume III, of 1894, pages 151 to 162.

The oil to be cracked is fed in through pipe, K, to the large pipelike still, passing successively through the divisions, B-1, B-2, and B-3, and B-4, the residue passing out through pipe, T, carrying with it the carbon, and being received in the receiver U, from which it can be drawn off through pipe and cock, W.

[fol. 221] The condensation as given in Fig. 2, is not under pressure, but, as given in the same article, on page 159, it is stated that the pressure valve can be placed in after the end of the condensation coil, when it is wished to condense the distillate under pressure, in other methods, and presumably in this method, as well.

He there discusses the advantages and the disadvantage of condensing under pressure.

In Laing's United States patent, No. 488,767, of December 27th, 1892, describes, somewhat, the same apparatus as in the citation which I have just given.

On page 2, line 29, he states that the still may be fed continuously. This would be through the pipe, K, the oil cracked in the large cracking still, and the residue drawn out through the pipe, T, would carry with it carbon left as a by-product in the cracking process.

There is some condensation in the reflux, M-1, M-2 and M-3, which are under atmospheric pressure, but, this is not the large condenser, the vapors for the large condenser passing from N through the valve X, to the condenser. If these vapors would be condensed under pressure—in other words, if a valve was placed at the end of the condenser, as Laing has suggested as common practice at this date, it would be a complete description of the process which you have read to me.

Pielsticker, British Patent No. 1,308, of 1891, being "Petitioner's Exhibit No. 133," describes a process identical with that that you have mentioned, excepting that he prefers to condense under atmospheric pressure.

In this case the oil is warmed in tank A, as shown in Fig. 1, passed through the pump C, and is fed into the coil D, where it is partially cracked, passing out from there into the tank I, of Fig. 2, where it is further cracked, and the residue carrying carbon passes out through the cock N, to some container not indicated.

The process is one working under pressure, and is obviously a continuous process, the vapors passing out through the dome P, through the valve R, to the condenser. The condenser would have a valve placed at its exit end, and in such case it would be a complete description of the process which you have described, and even without it, it is a description, with everything excepting the condenser under pressure.

And in this connection it must be borne in mind that at these dates, of 1890, until even after 1900, kerosene was the [fol. 222] product primarily wished, and not gasolene, and accordingly, there was little advnatage—in fact, some disadvantages—in condensing under pressure, so both processes, condensing under pressure and condensing under atmospheric pressure, have been well described in the various literature on the subject.

Q. Would it affect the operations of the carbon remover, or heating arrangements, whether the vapors were condensed under heavy pressure, or under atmospheric pressure?

A. It would not affect them, at all. In the Russian Patent Schuchow & Gavrilow, No. 4,782, of 1891, being "Petitioner's Exhibit No. 129," we have a process which again meets all the requirements of your question, excepting the condensation under pressure.

In this case the valve is placed between the cracking still and the condenser, instead of after the condenser, as Laing has described in 1894.

Q. Would the pieces of coke, or iron in the dome, of the Schuchow, et al., Patent, assist in separating the carbon from the liquid passing through the heating tubes, or separating the carbon and the liquid from the vapors?

A. It would assist in separating the carbon and liquid from the vapors, and it would assist, in a minor way, in separating the carbon from the residual liquid.

Another description of the process which meets your question, is that of Kittle, French Patent No. 417,532, of November 16, 1910. The oil is fed from the tank A, through the

cock A-1, to the cracking coil D, and the vapors are taken off from the tank F, through the pipe f, and passing through a valve, reaching the condenser G, the residual liquor carrying the carbon is dropped into tank, F, and removed therefrom by the pipe F-2, and cooled, and passes into the container, K. The process is under pressure, but the condensation, again, is one in which pressure is not preferred.

Q. In the Russian Patent to Intschick, No. 4,584, No. 220, of 1890, "Petitioner's Exhibit No. 120", are hydrocarbon oils supplied continuously to the retort, and is the carbon removed from the heated portion of the retort?

A. Yes. The feed is shown, perhaps, best in Fig. 16, where it is fed continuously, and the schemes for removal of carbon, in Figs. 9 and 11. In the specification it says—in the translation:

"The soot is knocked off"—I am reading from page 9 of my copy of the Translation—

"And wire discs in the form of brushes, can be placed on chains."

Q. In the Intschick apparatus, are the connections from the retort to the condensing apparatus all in open communication, so that a substantially uniform pressure would be insured therethrough?

A. They are.

Q. Is pressure mentioned in this Intschick patent?

A. Yes. It is on page 4 of my Translation. The statement is:

"The gas entering under pressure, which it has in the retort, through tube, A, through the water to the opening in the bell, O."

[fol. 223] That is on page 4, line 21, page 4, of this typewritten translation, the tenth paragraph, if the title of the patent is taken as the first paragraph.

Q. In the art that you have mentioned, or in any other art prior to 1911, relating to the same subject, is the carbon produced by the cracking temperature, permitted to descend out of the heated body by gravity? If so, will you please point out which of these patents or publications disclose this feature?

A. In the Intschick, Russian patent, No. 4,584, of 1890, "Petitioner's Exhibit No. 120", this carbon descends by gravity from the cracking still.

The design of the apparatus, as shown in Kittle, No. 417,532, French patent, of November 16, 1910, is such as would permit the liquid carrying the carbon—in other words, the residual liquid—to descend through the coil to the vessel, K, by gravity, so the whole apparatus is apparently at an elevated pressure. The movement of the liquid, for this portion, however, is apparently due to gravity.

The English patent to Gaster, No. 6,739, of 1901, carries a still with scrapers, where, also, the portion which has not been scraped off, but which has been formed in the body of the oil, would drop to, by gravity, the tanks, 23, as shown in Fig. 1.

In the United States patent to Warden, No. 110,806, Jan-
[fol. 224] uary 3, 1871, we have a similar still, in which any carbon formed in the vertical pipelike retort, B, would drop to bottom of that retort, and be removed by the pipe at the bottom of the retort, lettered, N. These illustrate such cases where carbon is removed by the aid of gravity.

Q. In any of the art that you have just described, is the oil heated in a confined stream of limited cross section and then passed to a vapor dome in which the carbon and heavy residue are separated out?

A. We find such a heating and pipelike structure in Kittle, French patent, No. 417,532, of November 16th, 1910, Petitioner's Exhibit No. 131. We find the oil cracked in the coil of pipelike structure, B, (I am referring now to the figure) and the heavy oil carbon separating out from the gasolene and kerosene or other cracked vapor products in the tank, F, and passing on through the pipe, f^2, into the container, K.

Q. In connection with that patent of Kittle, your understanding is that the carbon would be swept out of the tube?

A. Yes, and in fact it is stated in the Translation:

"In passing from the worm B into the separating chamber, F, the vapor can entrain with it a little quantity of unvaporized oil and impurities."

The oil and impurities are led through the pipe, f^2, and the cooling worm, J, into the reservoir, K, with an over-

flow, K¹. This is given in the paragraph of the original French, beginning at line 6.

Q. Will you count the paragraphs from the beginning of the patent, so that we may identify it?

A. It is the 26th paragraph from the beginning of the patent.

In the Russian patent, Schuchow and Gavrilow, No. 4782, of 1891, same being "Petitioner's Exhibit No. 129," we find a similar tank, A, but in this case placed above the coils, rather than below; the movement of the oil in this case being upward through the coil instead of downward, as in the case of Kittle, but it serves the same purpose.

Q. In any of the art that you have mentioned in connection with the previous questions, whether condensing under pressure or not, is there disclosed a process of converting oil which consists in continuously passing oil in a relatively thin stream under pressure through a pipe-like heater to a larger container or vapor dome in open communication therewith, heating said oil locally as it passes [fol. 225] through said pipe-like heater to a cracking temperature, removing from said pipe-like heater the collecting carbon resulting in said pipe-like heater, maintaining the substantially same vapor pressure on said oil in said heater and vapor dome?

A. In Pielsticker British patent, No. 1,308 of 1891, Petitioner's Exhibit No. 133, we have as shown in Figures 1 and 2 such a process illustrated.

The oil is passed by the pump, C, in a thin stream through the coils, D, and from there into the larger container, "I", and it is in open communication with it.

It is at a cracking temperature, in fact, in the coils, B, and is further cracked in the vessel, I,—large container, I. The residual product carrying the carbon is removed from it through the cock, N. The condensation in this case is not under pressure, the vapors are removed off from this vessel, I, through, P, and the cock, R, pipe, U, and condensed.

French patent to Kittle, No. 417,532, being "Petitioner's Exhibit 131," passes the petroleum under pressure through the pipe-like heater coil, D, and from that into a larger container, F, from which the residual oil carrying the carbon is removed to the receiver or tank, K. The vapors are

removed from this larger container, F, through the pipe, *f*, to the condenser, G, and accordingly, this is a description of the process you have indicated.

The Pielsticker United States Patent No. 477,153, of June 14, 1892, being "Petitioner's Exhibit 134," described a process identical with that which I have given in connection with the Pielsticker British Patent reference. So it also meets the description which you have given.

In the German Patent No. 166,723 to Clercq, "Petitioner's Exhibit 130," we have the oil passing by means of the pump, C, through the pipe 93 into the coil, *a*, and from there into the tank, *d*, the vapors from this passing over through the pipe, E, to a condenser. The carbon would remain and collect in the tank, *d*, and it has a large drawoff to the right for removal of such residual products from the tank, *d*. The condensation is not under pressure, the coils are only under pressure due to the pump. It is an apparatus primarily to be used for the handling of tar of heavy character and accordingly it is quite viscous and requires pump pressure to cause it to move.

Q. In the art prior to 1911, to your knowledge, is there disclosed any process in which oil is continuously fed under [fol. 226] pressure to a vertically arranged chamber, is heated in said chamber above its bottom to a cracking temperature, while maintaining vapor pressure of said oil in said chamber, allowing the carbon to descend by gravity to the bottom of said chamber beyond the heating zone and continuously passing the vapor generated through connections to a condenser; I mean whether condensing under pressure or not?

The Master: What is the distinction between that question and the last one?

Mr. Rauber: This one brings out the fact that the oil in the vertical chamber is heated above is bottom.

The Master: I thought so. Can you not answer that without analyzing the figures in the patent?

The Witness: I can.

A: Such a method is described in Kornfeld French Patent No. 328,058, being "Petitioner's Exhibit 123" and is illustrated in the figure in connection therewith.

Q. Is such a process also described in the Barbet French Patent No. 380,282?

A. It is.

Q. Have you read and do you understand the Adams Patent No. 1,461,017?

A. I have read it and I understand it.

Q. How do the disclosures of this Patent No. 1,461,017, compare with those of Adams Patent No. 1,327,263 that you have just discussed?

A. It is essentially the apparatus patent corresponding to the process described in the Patent No. 1,327,263 of January 6, 1920.

Q. How do the disclosures of this Adams Patent No. 1,461,017, compare with those of the French Patent to Kornfeld No. 328,051?

A. The primary parts of interest in the two patents are identical, or nearly so. The disclosure of importance in each case is a series of cracking chambers consisting of vertical pipes heated intermediate, at their tops and bottoms.

Q. How do the disclosure of the Adams Patent No. 1,461,017 compare with those of the French Patent to Barbet No. 380,282 and Patent of Addition No. 8,213?

A. Both of these French patents disclose vertical retorts for cracking purposes, heated intermediate at their ends, as does Adams.

Q. Referring more particularly to Fig. 5 of the Adams Patent, what elements in the Barbet and Kornfeld patents correspond to the vertical tubes, 9?

A. In the Barbet Patent No. 380,282, we have the vertical pipes, H, corresponding to these pipes, 9, of Adams.

Q. Do the pipes, 8, of Barbet enter into an upper dome corresponding to dome 10 of Adams', and a lower dome corresponding to dome 30 of Adams'?

A. They do. In the Kornfeld we have an upper dome, H, which though in the figure it is surrounded by heated zones, it is stated in the text it may be without the heated zone.

Q. Where, in the text, do you find that?

A. The last paragraph before he claims, reads:

"I can besides arrange my boiler in any convenient manner and particularly I can have on a single collector as many generated tubes as are desired. I can also arrange my boiler in such a way that the tubes, *a*, are alone

enclosed in the heating chamber while the collector will be placed outside this chamber."

Q. In the art prior to 1916, do you find any apparatus which comprises a combination of an elongated, vertical chamber adapted to contain oil, and the vapors under pressure; means for supplying oil to said chamber; means for externally heating said chamber above its bottom and below its top; means for removing carbon from said chamber below the heating zone; means for removing vapors and unconverted oils from said chamber above the heating zone; means for maintaining the self-imposed vapor pressure in said chamber and means for condensing the vapor?

A. The Russian Patent No. 4584 of 1890, being "Petitioner's Exhibit 120," describes such an apparatus.

[fol. 227] Lennard, United States Patent No. 659,076, of October 2, 1900, being "Petitioner's Exhibit 121," would be such an apparatus.

Bacon, Brooks & Clark, United States Patent No. 1,131,309 of March 9, 1915, describes such an apparatus.

Barbet French Patent No. 380,282, of October 4, 1907, being "Petitioner's Exhibit 124," describes such an apparatus. It is also described in the Barbet French Addition Patent No. 8,213 of February 8, 1908, being "Petitioner's Exhibit 125."

The Master: Is there any connection between the application for No. 1,461,017 and for 1,327,263?

The Witness: Yes. A connection is given showing that one is for the apparatus and the other for the process on page 1 of No. 1,461,017, lines 16 and 17; that is, that this one which was applied for December 5, 1917, is the apparatus application for the process, which was applied for December 31, 1909, which matured into Patent No. 1,327,263, issued January 6, 1920.

Q. Will you please give the patent number of serial No. 618,011?

A. The patent number corresponding to serial No. 618,011 is No. 1,327,263 patent of January 6th, 1920.

Q. In the Russian patent to Schuchow and Gavrilow, No. 4,782, No. 175, of 1891, if you consider the heating tubes, D, to be straight, as described in said patent, would

this patent disclose an elongated, vertical chamber adapted to contain oil and vapors under pressure; means for supplying oil to said chamber; means for externally heating said chamber above its bottom and below its top; means for removing carbon from said chamber below the heating zone; means for removing vapors and unconverted oils from said chamber above the heating zone; means for maintaining the self-imposed vapor pressure in said chamber; and means for condensing the vapor?

A. It would.

Q. In your answer, did you notice that I asked whether the carbon was removed from the chamber below the heating zone?

A. I overlooked that. It is removed from the chamber above the heating zone instead of below.

Q. In this patent, are there means for separately removing vapors and unconverted material above the heating zone and returning the unconverted material to the chamber for retreatment?

A. They are.

Q. Is this true also of the French patent to Barbet, No. 380,282?

A. Yes.

Q. Have you read and do you understand Adams patent, No. 1,462,677?

A. I have read and I understand it.

Q. From your reading of this patent, what do you consider to be the most characteristic features of the process described therein?

A. The heated oil is sprayed into a vapor chamber-giving a vapor phase process.

Q. You mean a vapor phase cracking process?

[fol. 228] A. Yes.

Q. How does the process disclosed in this Adams patent, No. 1,462,677, compare in this respect with that disclosed in the Intschick Russian patent, No. 4,584, and No. 220, of 1890, "Petitioner's Exhibit No. 120"?

A. It is also a process which is a vapor phase process where oil is sprayed in.

Q. In the Intschick patent, is the oil sprayed in at the top of the retort in a manner similar to that in the Adams patent?

A. The spraying apparatus as illustrated in the Fig. 16 of the Intschick patent is distinctly different from that shown in the Adams patent, Figures 5 and 6, but the effect is essentially the same. In the Intschick patent there is no discussion of pre-heating the oil before spraying it in, whereas, in the Adams patent, that is a part of the process.

Q. I refer you to partgraph 15 of the Intschick specification; do you find any mention of a pre-heater?

A. I do.

Q. What is the purpose of this pre-heater?

A. It says that the liquid enters along the pipe, M, into the reservoir, K, serving as a hydraulic still for the gas, and as a pre-heater for the liquid.

I had overlooked this in replying to the second question, before, regarding this patent.

The purpose of the pre-heater is to heat the liquid before it enters the cracking chamber so that the cracking will take place as promptly as possible.

Q. I will ask you to compare the path of oil on the Intschick process, with that of the Adams process, Adams patent, No. 1,462,677.

A. In the process described in Adams patent, No. 1,462,677, the oil passes from the supply tank through a certain system of valves to the pre-heater, B, shown in Fig. 2, and also shown in Fig. 3, the oil passing from the tank, A, through a system of pipes, to the pre-heater, B, and then being sprayed at the top of the pipe, 28, in Fig. 2, or 27, in Fig. 3, the resulting vapors being then passed on through a condenser.

In the Intschick patent, we do not have sketched the supply tank, but we do have the passage in through the pipe, N, of the oil, and the reservoir, K, serving as a pre-heater, and from there the spraying on top of a vertical pipe, which acts as a vapor phase cracking retort.

[fol. 229] Another analogy is that in Fig. 2, of Adams, we have a scheme for removing carbon, whereas, in Figures 9 and 11 of Intschick, we have not quite the same, but similar schemes of removing carbon from the vertical retort there shown—that is, there is, in each case, a spraying of the oil at the top of the vertical retort, carrying a scheme for removing carbon mechanically.

Q. On page 8 of the Adams patent, No. 1,462,677, it is stated that the temperature may go as high as 1500 degrees Fahrenheit. How would that compare with the temperature that Intschick would use in carrying out his process?

A. I do not find in the Intschick patent, a definite statement as to the temperature used, in degrees. I do find, however, that it is stated in paragraph 17, that: "There is obtained a tar containing aromatic hydrocarbon, of which there are none in the crude oil in its ready form. They are formed by the decomposition of the oil from the aggregate, or new chemical combination."

This formation of aromatics would show that we were using, that we could use temperatures as high as the temperature of 1500 degrees, F., as aromatic compounds do not begin to form, in quantity, until approximately that temperature.

Q. In the Intschick process is the oil delivered to one end of a plurality of vertical converter tubes and forcibly passed there through, under superatmospheric pressure?

A. Yes—for it is stated, in Paragraph 8, "The gas entering under pressure which it has in the recort, through tube, A," and so forth.

Q. Are the converter tubes heated intermediate their ends to a cracking temperature, whereby the oil is converted, in its passage there-through, in the Intschick process?

A. Yes.

Q. In the Int-chick process is there anything described for the purpose of collecting carbon at the bottom of the tubes, and removing it?

A. Yes, there are certain openings closed by plates, which can be used for that purpose.

Q. Do you find any of the features mentioned in the above three questions, disclosed in the Barbet Patent, No. 380,282?

[fol. 230] A. I do find several of these features—in fact, I believe all of them.

Q. Have you read Adams Patent No. 1,462,678, and do you understand the disclosures therein?

A. I have read it and I understand it.

Q. How do the disclosures of this Adams Patent compare with those of Adams Patent No. 1,462,677?

A. It is the apparatus patent, corresponding to the process patent, No. 1,462,677.

Q. In the prior art, prior to 1916, to your knowledge, is there disclosed an apparatus for converting high boiling hydrocarbon oils into lower boiling products, comprising a furnace, a plurality of vertically disposed converter tubes located therein and heated to a cracking temperature under superatmospheric pressure and having their respective ends projecting through the upper and lower walls thereof, means for delivering oil to said vertical converter tubes and forcibly passing it under pressure in flowing streams therethrough, whereby it is converted in transit, means for conducting off the unconverted liquid oil emerging from the converter tubes, a chamber connected to the lower ends of said vertical converter tubes for receiving the carbon and heavy residue formed in said converter tubes, means for removing carbon and heavy residue from said chamber, and means for withdrawing from the system the vapors evolved in said converter tubes?

A. Such an apapratus is described in United States Patent No. 1,131,309, to Bacon, Brooks & Clark, issued March 9, 1915, being "petitioner's Exhibit No. 122." This, particularly in Fig. 2, illustrates an apparatus filling all the conditions which you have mentioned in your question, the oil entering at A, passing down the tubes, cracked, and the residue passing out from the container, E', through the pipe, M', t-e vapors passing out through the pipe, I', to the condenser.

We have a single unit of such apparatus, illustrated in Fig. 1.

In Intschick, Russian Patent No. 4584, of 1890, being "Petitioner's Exhibit No. 120," we have a similar sort of vertically disposed converter tubes, but, unlike those illustrated in the figures of Adams, and of Bacon, Brooks & Clark, these are arranged, by preference, in the form of a circle, five or more units constituting the set.

[fol. 231] We have in this case, as in the other case, the oil sprayed in at the top, cracked by the heat at the intermediate portions, and the residual oil, with carbon, removed from the bottom.

In other words, it completely meets the description which you have read.

In barbet, French Patent No. 380,282, of October 4, 1907, being, "Petitioner's Exhibit No. 124," and which is an improvement on the Barbet Patent No. 1,322,265, describes such an apparatus.

The reason for mentioning the relation to the patent, of which this is an improvement, is that the original patent works under pressure of 5 to 6 atmospheres, and it is not discussed in this Patent No. 380,282, as to what is the preferred pressure.

Further, we have in the Kornfeld Patent, No. 328,051, being "Petitioner's Patent No. 123," a similar apparatus, with the exception that there is no chamber at the bottom of the tubes, for removing carbon and heavy residue from it, the carbon and heavy residue passing out with the vapors—that is, borne out by the heavy vapors and rapid movement of the gases, so far as they are removed from the retort.

Q. In connection with your last answer, I will call your attention to the next to the last paragraph in the patent to Kornfeld, No. 328,051, and I will ask you to state whether you find any mention of the disposal of the residues, in that paragraph?

A. I had overlooked that paragraph, and I find as follows, in that paragraph:

"The residues contained in the petroleum, and which have not been volatilized, remain in the tube, A. From time to time it is necessary to remove these residues. In the case where the decomposition of the petroleum has been pushed up to the formation of coke, those deposits on the walls of the tubes, A, the cleaning of those tubes is affected by means of a borer, or scraper, calibrated to enter these tubes. An opening, Z, with stopper, Z, can be arranged on the collector, and opposite each tube, to permit the cleaning tube to be introduced through this opening."

This gives a different means of removal of residue, from what I indicated in the previous answer.

[fol. 232] Q. Have you read, and do you understand the disclosures of the patent to Chamberlain, No. 1,211,790?

A. I have read it, and I understand it.

Q. How do the steps of this process compare with those of Dewar and Redwood, Laing and Young, in the prior art,

disregarding the material treated in the Chamberlain process?

The Master: One operates on one kind of stock and one on another—is that the point?

Mr. Rauber: I had in mind comparing what it does with the stock, rather than the stock itself.

A. In Dewar and Redwood, we have essentially the same kind of process, excepting that the condensation is exclusively under pressure.

In Laing we have essentially the same process, the condensation not being under pressure.

In Young we have an operation at a pressure of twenty pounds instead of the ordinary pressure used in distillation—that is, around five atmospheres—and the condensation is under atmospheric pressure, as it also is in the case of Chamberlain.

In other words, the Chamberlain process is essentially the same as we have had in the prior art.

The Master: Except that it carries it to a higher degree?

The Witness: No, it does not.

Q. How does the process to which the oil is subjected in the Chamberlain process, compare with the process described in the French patent to Barbet, No. 322,265, "Petitioner's Exhibit No. 136," and particular reference being made to the Barbet French patent?

A. The two processes work at essentially the same pressure—around five atmospheres—Barbet specifying five to six atmospheres, Chamberlain 75 pounds, which would be slightly more than five atmospheres, though he also suggests, sometimes, the use of a different pressure.

The cracking process is essentially the same, the condensation is essentially the same, both being without condensation under pressure.

Q. From your reading of the Chamberlain specification, what do you judge to be the characteristic feature of the Chamberlain process?

[fol. 233] A. The cracking of oil under pressure, at seventy-five pounds pressure.

Q. Is any mention made of any particular oil?

A. He describes, in very many sentences, and long ones, types of oil, but when one reads these carefully, it comes,

in general, to the ordinary petroleum, and the words, in many cases, "Ordinary Petroleum," could be substituted in place of whole paragraphs—or, at least, for whole long sentences.

Q. From your reading of the Chamberlain patent, do you, therefore, conclude that he is merely specifying petroleum by certain characteristics?

A. Yes. In some cases he does specify a distillate, which would follow that obtained after distilling off gasoline and kerosene, and distilling the residue to dryness, the remaining portion after the kerosene, would meet his specifications for oil, but in other cases it is simply a description which most ordinary crude petroleum would meet.

The Master: Could anybody skilled in the art, reading Barbet, and following it, produce the same results, by the same means as Chamberlain does?

The Witness: Yes. The apparatus used is somewhat different, but the means is the same.

Q. What kind of oil would have a viscosity of about 72 seconds, Engler?

A. That would be about the dividing point in ordinary oil between kerosene and a product that is commercially known as gas oil. Gas oil, I might add, has essentially no relation to gasoline. It is not the same as we have come to abbre-[fol. 234] viate by saying: "Put gas into our car." We mean there, gasoline, but gas oil is the oil which is one of the by-products of the petroleum industry in the days before cracking became important and was used for adding to ordinary coal gas or water gas used for illuminating gas purposes in order to increase the candle power of that gas and the B. T. U., the heat value of that gas. It was added to it.

The Master: What they called the water gas?

The Witness: Yes, enriching it. In that process it went through a decomposing or cracking process to obtain not liquid hydrocarbons of our motor fuel type but instead hydrocarbons which served to enrich the illuminating gas and were gases. This gas oil was, at certain times, cheaper per gallon than the crude oil from which it was made, being a byproduct and merely a waste product.

Q. What type of oil would have a viscosity of 170 seconds Engler, at 100 degrees Fahrenheit?

A. That is about the dividing point, according to Chamberlain and others, between gas oil and lubricating oil, so that the range from 72 seconds to 170 seconds would be the gas oil range.

Q. Does American crude petroleum contain gas oil?

A. It does.

Q. About what proportion does gas oil exist in crude petroleum?

A. It varies with the crude petroleum but would be in the ordinary grades of crude petroleum—well, ordinarily around fifteen per cent. It will vary considerably with the petroleum, the ones which have most gasoline and kerosene, would have the smallest amount, and those which are low in gasoline and kerosene, for example, such as the Gulf Coast oil, would have much higher percentages, but oils having a higher percentage in kerosene, such as Pennsylvania oil, being lowest in percentage.

Q. When the gasoline and kerosene is distilled off, the proportion of gas oil that remains, would that ordinarily be about fifteen per cent?

A. It would, even in such an oil as the Pennsylvania oil. Of course, the exact point at which it is cut to make a gas oil varies according to the market demand. If they can sell a very light lubricating oil at a good profit, that is sepa- [fol. 235] rated and sold as lubricating oil, otherwise, it would go into the gas oil.

Q. What significance does the viscosity of an oil have in cracking?

A. Very little, excepting to show that the ones which are more viscous are higher boiling and are heavier density and higher boiling, the three factors generally going together, though not always. If we have, for example, an oil which has been previously cracked, that is the residue from cracking it will likely be low in viscosity, though high in boiling point.

Q. From what you have just said I judge that an oil that contains hydrocarbons with viscosities of from 72 seconds to 170 seconds at 100 degrees Fahrenheit, and also liquid hydrocarbons of higher viscosities, in the relative proportion of not less than ten per cent of hydrocarbons by volume of every kind, but not to exceed ninety per cent of hydrocarbons of the other kind, that would describe a great many of the crude petroleums, is that correct?

A. That is correct.

Q. What do you understand to be still wax?

A. Still wax, as I understand it, from reading the Chamberlain patent, that is his interpretation of it there, is the residue which is left in the still after an atmospheric distillation of the heavier hydrocarbons, that is, the paraffin and lubricating oils having distilled off, it would be material which would be probably chemically related to our paraffin hydrocarbons and at the same time there probably would be some asphaltic materials mixed with it.

It is not, so far as I know, a definite chemical compound, in any sense. It is, rather, an indefinite term for the residues.

Q. What is paraffin wax?

A. Paraffin wax is the solid wax which is sold under the general name of paraffin and is a hydrocarbon, largely of a saturated hydrocarbon or mixtures of hydrocarbons—largely saturated hydrocarbons which have melting points in the general range of temperature slightly below blood temperature.

Q. Do shale oils contain these various products?

[fol. 236] A. Yes, they do, the wax indeed being somewhat higher melting than that which is obtained from ordinary petroleum work, subject to the same purification.

Q. When you gave the melting point of paraffin wax did you have in mind a purified wax?

A. Yes, the commercial waxes. These melt at, I said below blood temperature, I should have said above blood temperature. These melt in the general range—oh, around 130 Fahrenheit. The paraffin wax from shale oil generally is obtained of a somewhat higher melting point than the corresponding grades of well petroleum wax.

Q. Do you know of any disclosures in the art prior to 1913 in which paraffin oils of the shale or American petroleum type, and free from still wax and other heavy matters of sticky character have been distilled under a pressure of more than 30 pounds above atmospheric pressure for the production of lighter hydrocarbons?

A. Using free from still wax and sticky matters in the sense that Chamberlain uses it, I would say that the Dewar & Redwood process, as described in their United States Patent, and the similar disclosure in Redwood's Petroleum,

would meet this condition. The exact pressures are not given, but they are said to be "considerable" or "high" pressures; Pielsticker describes a process which would probably be operated, or which could be operated in such a way, but pressure is not given there. He states it works under pressure, and in general, the various earlier citations which we have had of operations of cracking under pressure would, in general, cover this process which you have described.

Q. Do you know of any disclosures in the art prior to 1913 that would indicate that it is customary to crack distillates such as gas oil?

A. In the early work in cracking (that is, I refer to forty years ago or more) the cracking was essentially for the purpose of kerosene manufacture and was largely carried out using atmospheric pressure rather than superatmospheric pressure. The reasons for that, I think, were largely mechanical; that is, due to the difficulty of building apparatus which would stand both a high temperature and pressure simultaneously, they not having the present day types of steel.

In the volume by Crew: "A Practical Treatise on Petroleum," 1887, and written by Crew before his death, November 1885, so it refers to earlier work than that, we have in his Chapter on "Technology of Petroleum," the statement that (I am quoting now from page 280):

"After all the oil that can be safely run into the illuminating oil has been removed from the still, and when the darkened product would impair or imperil the color-test, the fires are usually withdrawn from the still and preparations made to remove the residuum and the coke. Some refiners prefer to continue the distillation a short time longer to recover a small percentage of oil, dark though it may be, which is run over with a fresh portion of crude oil."

This would be a gas oil because it is boiling above the kerosene.

Then, omitting a few lines:

"In former years it was customary to allow the still to cool for several hours after the fire had been withdrawn. The residium was withdrawn through a tail pipe at the rear of the still."

Then omitting a few lines:

"The residuum is now withdrawn by means of a pipe connected with a steam pump. The pipe passes by several returns of the same through a tank of cold water, which cools the residuum sufficiently to obviate this danger."

[fol. 237] He is referring to the danger of catching fire.

"It is pumped into a large settling reservoir or tank, where it is allowed to stand for several days to allow the subsidence of all the fine particles of coke, which will separate by this process. This tank is provided with an exit pipe placed at the distance of about twelve inches from the bottom of the tank, to admit of the drawing-off to the clear liquid, while a large opening or man-hole is placed on the side at the bottom to admit of the removal of the sediment. This is in the condition of slush, and is exclusively employed as fuel for the stills or boiler by mixing the same with fine coal dust or coke screenings. The residuum thus purified is pumped into storage tanks. In this condition it is either sold to the manufacturer of paraffine-wax and lubricating oils, or for the manufacture of gas, for which it has been largely employed, either to enrich the gas product of coal, or by itself."

Then omitting the rest of page 281, I am beginning again at page 282:

"After the subsidence of all the coke, the residuum is transferred by means of a pump to the residuum stills. These are generally built on the cylinder pattern, and should not much exceed two hundred barrels' capacity, and are set in banks of three. In stills of larger capacity, it has been found in practice that the quantity of solid coke residus is so great that the heat necessary to drive the still to dryness is so intense as to severely strain the bottom, making frequent repairs necessary."

Then, omitting the rest of that page, page 283 states:

"When the still is loaded, and the fire started, the distillation commenced. The first runnings from twenty to twenty-five per cent. (if residuum be of good gravity), say of 20° to 21° B, will be found sufficiently light in gravity

to be transferred to the crude oil tank and re-distilled from this."

That is, the crude oil tank whose contents is being used for cracking purposes.

Then, on page 288, referring to this same distillation:

"The first products of this distillation down to about 32° Baume (which when they are received into one tank, constitute an oil of 38°), are returned as crude oil."

That is, that would mean to the tank to be used for cracking.

Page 290:

"We have now divided the product of distillation of the [fol. 238] residuum into three parts: 1st. The lighter oils, which have been returned to the crude oil tank. 2nd. The crude paraffin, which for the present we leave in the presses; and 3d. The refined heavy oil, which in its present shape may be either sold for lubricating purposes, or subjected to further treatment for special purposes."

This would be an illustration of distillate made at atmospheric pressure, which distillate is then cracked.

Q. Have you read and do you understand the disclosure of Burton and Clark patent, No. 1,448,254?

A. I have read it and I understand it.

Q. What do you consider to be the most characteristic features of the process described in the Burton et al. patent?

A. The flowing of the feed oil counter-current to the vapors in the run-back; the feed entering in through pipe, 24, and the run-back being indicated in Fig. 1 by pipe, 16. By this process we have the simultaneous passing back into the still in mixed condition of the liquid from the run-back and the feed oil liquid when the process is being operated or continued to feed over a time.

Q. What other features do you notice in this process of Burton and Clark that would distinguish it, for example, from the process described in Clark's patent, No. 1,119,496?

A. In the Burton and Clark we have a repetition of the scheme which is applied in the Patent No. 1,119,496 of heating tubes and bringing the product to a tank, but the appa-

ratus used for this is of different shape and character. The two methods, though, are essentially the same in this respect: In the case of Clark we have the passing of the liquid through the tubes, 4, where they are heated, to a tank, 1. In the Burton and Clark we have it passing from the tubes, 10′, to the tank, 10.

Q. What is the purpose of the funnel and pipe 29 and 30, respectively in the Burton and Clark patent?

A. This is to bring the oils which are being introduced as liquids into the still, to bring them into the pipe, 32, which has a downward current so that they will be brought as promptly as possible into contact with the walls of the tubes, 10′; whereas, if the funnel, 29, and the pipe, 30, were not there we would have that the material would drop into the tank at the level of the oil, whatever that might be, roughly as indicated by the dotted line and would mix with the mass of material in the tank.

By this scheme they are at once brought into contact with [fol. 239] the highly heated pipes, 10′, and cracked more promptly and more vigorously than they would otherwise be cracked.

The Master: Do the products go over into pipes, 30, as vapors?

The Witness: No, as liquids.

The Master: What is the indication of the dotted line there?

The Witness: I understand that to be the level of the liquid in the tank, 10. There is no definite statement that I recall as to it, but that would be about the right height for the level of the liquid in the pipe in tank 10.

The Master: If that is the level of the liquids, how would the liquids reach the top of the tank?

The Witness: No, the liquids are the liquids that come back on this figure, back through the run-back here where they are cooled by air cooling here (indicating), and by the introduction of the new feed of liquid into the bottom of pipe, 16.

Q. Please state whether or not to your knowledge the art prior to 1916 disclosed a process of distilling hydrocarbons for the pyrogenesis of lower boiling point hydrocarbons, which consists in maintaining a body of hydrocarbons treated in a receptacle under superatmospheric pressure,

floating a stream of said hydrocarbons through a heated zone to said receptacle; cooling vapors evolved to condense their heavier constituents supplying this condensate to said flowing stream?

A. It does.

Q. Will you please point out wherein such process was disclosed?

The Witness: If your Honor will bear with me I think that in this case it will be necessary to trace through the various diagrams the flow of liquids, in replying to this question.

The Master: Very well.

A, I wish to call your attention to Greenstreet, No. 1,110,924, September 15, 1914, which is "Petitioner's Exhibit 128." This is a process carried out under pressure and receptacle 34 contains the hydrocarbons under pressure. They pass out——

The Master: That is, 34 would correspond to what here (indicating)?

The Witness: Would correspond on Fig. 1 to tank, 10, on Fig. 2 to tank, 10, and pipes, 10'.

[fol. 240] The Master: Yes.

A. (Continued). We would have the passing out of this hot material through the pipe, 68, to the tank, 47, of Greenstreet, and further by the pipe, 69, to the pump, 15, where it is sent to the tanks, 8 and 9, and from there through the pipe, 5, to the inlet coil at 3 and down through the coil up through the vertical pipe, 33, and back to 34.

In such case we have the stream of hydrocarbons passing through this heated zone, that is the cracking coil, to this receptacle 34; the vapors are cooled, condensing their heavier constituents and the heavier constituents pass out, as I said, through 68 and through the pump, 15, and are there mixed with the new oil to be cracked and sent back into the system.

Q. Is there any condensation of vapors in the tanks beyond 34 returned to the heating coil?

A. Yes, in tanks 35, 37, 38 and 39; beyond that they are not returned to the heating coil.

A second disclosure of this same process which you have described in your question is in the British Patent to Piel-

sticker, No. 1,308 of 1891, "Petitioner's Exhibit 133." In this case we have to remember that the apparatus indicated in Figs. 1 and 2 are actually operated in series. Considering the tank, I, which receives the heated oil and vapors from the tubes, B, we would have this operation carried out, if we use in the place of the small dome P, the larger dome P, as indicated in Fig. 3, and returned, as Pielsticker suggests in line 44 of the second page of the specification, returned through P', the condensate to the process.

I read from lines 41 to 45:

"The dome, P, may be enlarged at its base forming a sphere and made to provide at its lower end inside with a cup-shaped projection, P, into which any oil collects which may condense in the dome, P, and from which it may be returned into the retort, I, or into the supply tank, A, through the pipe, P'."

I wish to consider here where it is returned to the Supply tank, A. We would then have the body of hydrocarbons treated in receptacle, I, under super-atmospheric pressure and re-flowing the hydrocarbons through the point, B, to this, returning the heavier condensate from P, through the pipe, P', to tank, A, which supplies the original cracking coils, and this would be a complete disclosure of the process as you have described.

We have, again, the same process described though with [fol. 241] different letterings on the various portions in Pielsticker's United States patent, No. 477,153 of June 14th, 1892, the same being "Petitioner's Exhibit No. 134."

In Laing's United States patent, No. 954,575 of April 12th, 1910, same being "Petitioner's Exhibit No. 135", we have an apparatus of which the patentee describes his use, and in such description we have the counter-part of the process which you have described in your question. Considering the coil, 8, as the receptacle mentioned in your question, then we will have operating under pressure the whole system; the valve, 46, being closed and, 45, being open. The process will operate in accordance with the process described in your question, the in-let oil being through pipe, 6, through the heater, 5, by the pipe, 45, through valve, 45, and through the other portions, as is obvious from reading the drawing and the text of the specification.

In Testelin & Renard, British patent, No. 16,881 of 1908, same being Petitioner's Exhibit No. 147, bearing in mind the statement on page 2, line 11:

"Decomposing the heavy products through apparatus again, they are finally transformed into light spirit."

We would then have the products in the receptacle, J, being under super-atmospheric pressure, and there is flowed to them, through the hot chamber, F, a stream of said hydrocarbons to this receptacle, the vapors from this are cooled in the coolers, B, B', B_2, and C, the heavier portions being condensed, and as I quoted from page 2, line 11, return this condensate to the in-flowing oil; that is, the flowing stream of oil.

Q. In any of the prior art patents, which you have mentioned in your last answer, is the condensate, which is condensed and returned to the heated zone intermediate between the hydrocarbons treated and the desired low boiling products?

A. That is true in the Greenstreet citation. First, I wish to ask a question: Intermediate in what respect; boiling point?

Q. Boiling point.

A. Yes, in the Greenstreet citation; in the Pielsticker British patent; in the Pielsticker United States patent; in the Laing United States patent and in the Testelin & Renard French patent, in fact, accordingly, in all of them.

Q. Please state whether or not to your knowledge the art prior to 1916 disclosed or contained a disclosure of a proc- [fol. 242] ess of distilling hydrocarbons, which consists in heating a liquid body of such hydrocarbons above it atmospheric boiling point under a pressure of upwards of four atmospheres, to effect distillation thereof, and feeding into such liquid body from an extraneous source a fresh stock of hydrocarbon having a boiling point under the prevailing pressure lower than the temperature of the liquid body thereby super-heating and cracking the in-fed material?

A. If the Dewar and Redwood United States patent, No. 419,931, of January, 1890, uses a pressure of upwards of four atmospheres, as would be indicated by the wording, page 1, line 58:

"Under considerable pressure;" on page 1, line 72:

"The cracking in this case taking place under high pressure instead of being carried on at atmospheric pressure," then the disclosure in this patent would be a complete disclosure of the process which you have described in your question.

In fact I think we can say that any process which is cracking under a pressure of four atmospheres or above, and which is continuously feeding in the same oil, would meet the process which you have described. I say this because the residue from the oil will have a higher boiling point than that oil has before it is cracked.

This is nicely illustrated on page 5, of the Chamberlain patent, No. 1,221,790, second column, where the temperatures of the liquid is given at the beginning of a distillation and toward the latter part of the distillation, and in each case we are to understand that the pressure is constant. The pressure is given for the temperatures of this liquid at 75 pounds gauge pressure, and at atmospheric pressure, and this would lead us to this opinion: That the in-coming oil will have a boiling point lower than the temperature of the residual oil in a still after it has been partially cracked, it being the presumption that the gasoline formed from it will be continuously removed as in the Chamberlain patent, or in the Burton or Clark, or in the Dewar and Redwood patents.

Q. In the Greenstreet, the Testelin, et al., and the Pielsticker processes that you mentioned, is fresh oil ever mixed with the oil being returned to the cracking zone or heated zone?

A. Fresh oil would normally be mixed with the condensed oil being returned to the cracking zone.

[fol. 243] Q. Will you please point out in the Greenstreet drawings where these two oils mix?

A. The oil supply tank is indicated in the drawing as tank, 17, and it passes by means of a pipe, 6, to the inlet of the pump, 15; the return condensate from tanks 34, 35, 37, 38 and 39 (that is the run-back) returns through pipe, 68, to the tank, 47, and by pipe, 69, to the same inlet of the pump, 15, from which pump it is pumped on to the cracking coil through an intermediate tank, 8.

Q. Have you read and do you understand the disclosures of Adams Patent No. 1,433,519?

A. I have read it and I understand it.

Q. What do you consider the characteristic features of the process described in this patent to be, particularly as illustrated in Fig. 3 of the drawings?

A. Fig. 3?

Q. Yes, Fig. 3.

A. The characteristic feature here is the internal electric heating. It is coupled, in Fig. 3, with a plurality of cracking chambers in which the operation is carried on in series; that is, the oil passes first through one then to a second, and the same oil through the third.

Q. To your knowledge, did the art, prior to 1917, contain any disclosures of a process of treating high boiling point hydrocarbons, which comprises continuously passing the oil to be treated under pressure, successively through a plurality of heating chambers connected in series, maintaining vapor pressure in each of said chambers on said oil and drawing off the vapors from each of said chambers?

A. In Laing, Transactions, Royal Scottish Societies, Volume 13, pages 151 to 162, published in 1894, we have an apparatus and a process described permitting this process to be carried out, which meets the process described in your question, if we consider these divided partitions, C, as separating cracking stills—in other words, that the oil is first in B^1, B^2, and B^3, then in B^4, and then finally drawn out through pipe, T, and the receiver, U, the vapors being drawn off.

In the Dewar and Redwood United States patent, No. 419,931, of January 21, 1890, we have another apparatus, in which the process can be carried out, provided we carry it out as indicated on page 2, lines 21 to 26, where he suggests the addition of a number of retorts, "so as to form a series of any required number."

Then we would have in each of these retorts a distillation [fol. 244] out, under pressure, of the vapors, also condensing under pressure, the oil would be passing in series through the group of retorts.

Redwood's Petroleum, 1896 Edition, Volume I, page 320 to 322, again describes essentially the same process, and we would have, in a similar way, a disclosure of the process as described in your question.

The United States patents to Laing, being patent No. 471,291 of March 22nd, 1892, and No. 488,767, of December

27th, 1892, disclose, particularly when taken in combination, such a series of chambers, being chambers in Fig. 2, of patent, No. 488,767, B^1, B^2, and B^4, with the vapors passing out from them, and in the other patent, which is concerned particularly with the phase of condensation, rather than with the cracking process, itself, we have the statement made that it cracks under a pressure of 80 pounds, or any other suitable pressure. Any of those would be a description of such a process as you have indicated.

Q. In the various processes that you have just mentioned, are the hydrocarbon oils in the various converters, or retorts, concurrently cracked—that is, cracked at the same time?

A. Yes, sir.

Q. In each of these is the oil separated from the vapors and passed to the next succeeding retort?

A. Yes.

Q. In any of the processes that you have just mentioned, are the vapors generated in the retort condensed under the same pressures under which they are generated?

A. That is true of the Redwood citation, Petroleum, Volume I, pages 320 to 322, of 1896, and of the Dewar and Redwood, United States patent, No. 419,931, of January 1, 1890, but not of the others. The others are condensed at atmospheric pressure, though Laing states, in the Royal Society Transaction, that it could be condensed at the same pressure as in the still.

Q. Please state whether or not, to your knowledge, the art, prior to 1909, disclosed a series of converters having their vapor spaces inter-connected?

A. Prior to what date?

Q. 1909.

A. We have such an inter-connection in the Laing article, in the Transactions of the Royal Scottish Society, of 1894, pages 151 to 162, and as particularly shown in Fig. 2, the [fol. 245] vapor space of the retort portion, B^1, being connected by the pipe, L^1, and the condser pipe in M', to the vapor space, B^2, B^2 being connected to B^3 by the pipe, L^2, and the pipe in the condenser, M^2, to the vapor space, B^3, the connection from B^3 to B^4, the vapor space is through pipe, L^3, and the condenser pipe M^3, in each case this being a somewhat tortuous, but still free communication of vapors.

Kornfeld, French patent, Uo. 328,051, has a direct connection between the vapor space. It is later than the date mentioned.

Q. What date is it?

A. It is nineteen—no, I mis-read it. I thought it was 1912, but it is 1902. Kornfeld would be a citation under this question that you mentioned.

Q. Are the vapor spaces in the apparatus of the Russian Patent to Intschick, No. 4584, No. 220, of 1890, "Petitioner's Exhibit No. 120," interconnected?

A. They are. I overlooked it in my answer to your previous question.

Q. Are the vapor spaces, heating tubes, or retorts in the French patent to Barbet, No. 380,282, "Petitioner's Exhibit No. 124", interconnected?

A. They are.

Q. Have you read, and do you understand the disclosures of the patent to Hall, No. 1,175,909?

A. I have read it, and I understand it.

Q. What do you understand to be the most characteristic feature of this patent to Hall?

A. I find myself a little at sea to say what is the most characteristic. I find two things—one, the sudden lowering of the pressure of the flowing mixture, containing suspended particles of carbon, by causing gases to flow into an expansion chamber; and then the second thing is the statement that the density partakes of the nature of a new product.

These two things are, I think, the parts that Hall thinks are the most important in his patent.

He does use catalyst in the cracking scheme, at a quite high temperature. He also condenses, normally, at atmospheric pressure.

Q. Please state whether or not, to your knowledge, the art, prior to 1914, disclosed a step in the production of motor fuel, of suddenly lowering the pressure of the flowing mixture, containing gases and vapors, and containing suspended particles of free carbons, carried by said mixture, [fol. 246] while causing said gases and vapors to enter an expansion vessel, wherein, the speed of flow of the gases and vapors is materially decreased.

A. Benton, in United States Patent No. 342,564, of May 25, 1886, describes such a step, in a process of making a cracked product from oil.

The oil heated in the coil, B, is released under high pressure, through the valve, G, and the outlet just above it, into the chamber, C, and would thereby cause the speed of flow of the gases and vapors to be changed. The oil in the pipe, coil, B, is especially in a liquid condition, and becomes vaporous when going into the chamber, C. The residue of carbon and other residual products, is drawn off through outlet pipe *h*. The vapors from C pass on through the header, H, to a condenser, D, and are there condensed.

In the British Patent to Testelin & Renard, No. 16,881, of 1908, we have a process using about 5 atmospheres pressure, in which the hydrocarbon oils, in the retort, G, pass through a valve at H′ into a vessel indicated by the letter A, and are there reduced in pressure, permitting the carbon particle and other residual materials to be deposited, and to be drawn off by means of a stop cock placed at the base of the vessel, A.

In the French patent to Kittle, No. 417,532, of November 16, 1910, we have a similar process described. The cracked hydrocarbons pass out from the coil, D, into the tank, F, and thereby have their velocity decreased. This permits the vapors to expand, their velocity to change, and the suspended carbon and residue can be drawn off from tank, F, by means of pipe, F-2.

Each of these three citations that I have quoted from describes the process you mention in your question.

Mr. Rauber: I offer in evidence British Patent to Renard, No. 3,413, of February 10, 1913, and ask that it be marked, "Petitioner's Exhibit No. 231."

(The said patent, so offered, was admitted in evidence, was marked, "Petitioner's Exhibit No. 231," and the same is herewith returned.)

Q. Will you please state whether or not, to your knowledge, the art, prior to 1914, disclosed any step in the manufacture of motor fuel from hydrocarbon oil, of which at least a portion has boiling points materially higher than those of ordinary gasoline, the step of passing such an oil, in the form of a flowing current, and a substantial absence

[fol. 247] of extraneous water, through a coil maintained at a temperature not materially below 500 degrees Centigrade, while at a pressure sufficiently low to allow vaporization but materially above atmospheric?

A. A temperature of 500 degrees Centigrade is the equivalent of 932 degrees Fahrenheit. I speak of that, now, because in some of the citations it is given as Centigrade, and some as Fahrenheit.

Russian patent to Schuchow and Gavrilow, No. 4,782, of 1891, being "Petitioner's Exhibit No. 129", discloses such a process.

Q. Do you find any mention of temperature in the Schuchow patent?

A. Not directly, but from the fact of the indirect evidence in the statement of the cracking work, one would infer that the temperature was approximately this temperature. Though it is not directly stated, as I recall, what the temperature is.

Q. In the French patent to Kittle, No. 417,532, "Petitioner's Exhibit No. 131", do you find any temperatures specified?

A. It is said that the temperature within the coil is ordinarily 500 degrees Centigrade. This statement is made in line 43, page 2, of the French text, and this disclosure in this French patent to Kittle, would be a description of the process which you have mentioned in your question.

Q. Have you read, and do you understand the disclosures of the patent to Palmer, No. 1,187,380?

A. I have read it and I understand it.

Q. What do you understand to be the most characteristic feature of this Palmer process?

A. The cracking of heavy residues by heating at rather high pressures,—say around 400 pounds pressure—and 200 degrees Centigrade, for a time, and then afterwards distilling, the separation of the two steps being apparently an essential part of the process.

Q. In your answer you stated that the process was applied to heavy residues. Referring to the original specification in the file wrapper of this Palmer patent, No. 1,187,380, on page 1, did you find anything that would indicate the type of residues that were suitable for use in this Palmer process?

A. I find the following statement as to the raw materials to be worked upon, in the specification, page 1, the first two paragraphs:

[fol. 248] "My invention relates particularly to improvements in making various hydrocarbons of the aromatic series, from crude petroleum, residues, heavy oils resulting from the distillation of bituminous coal, and the like, and from the residium resulting from the manufacture of oil gas, including any other source of heavy liquid, or solid hydrocarbons, from which volatile hydrocarbons may be derived. Among the various materials treated are mineral or vegetable, or animal, tars, pitches, asphalt, resins, gums, oils, paraffins, which are either non-volatile, partially volatile, or volatile with difficulty, and also other mineral, vegetable and animal materials, or compounds capable of acting in a similar manner to the above."

Q. Will you please state whether or not, to your knowledge, the art, prior to 1907, disclosed the treatment of residues of this type, under heavy pressures and high temperatures, and particularly at several atmospheres?

A. I think perhaps a good description of the same process is given in Thorpe & Young, proceedings of the Royal Society of London, Vol. 19, pages 370 to 371, of 1871.

Palmer speaks of the use of paraffins, and Thorpe & Young describe a cracking process, in this article of 1871, in which they obtained about a 33 per cent yield of products boiling within the gasoline range. This was cracked under pressure, and then later distilled.

Q. Can you point out some instances in the art, prior to 1907, in which still higher pressures were used—pressures more nearly those described in the Palmer patent?

A. Lobry d Dedruin, in an article in the Chemischer Zeitung, of 1895, on page 855, describes the distillation of fish oil at 15 atmospheres pressure. Fish would come under his designation of animal material, and under the designation of oils.

Lobry d Dedruin uses a pressure of 15 atmospheres, and shows the formation of water and petroleum, and then the cracking of the products to give inflammable gases—that is, the cracking of it to give products which we ordinarily get by cracking petroleum.

15 atmospheres would be approximately 220 pounds.

Engler-Hofer, in a book, Das Erdol——

Q. The date I asked for was 1907.

A. This is later—this is 1909.

Engler, in his article on the Artificial Production of [fol. 249] Petroleum, in the Journal of the American Chemical Society, Vol. 15, pages 379 to 388, 1893, discusses the production of petroleum from animal fats, and shows, on page 380, line 34, a pressure of 25 atmospheres as a desirable pressure at which to operate. 25 atmospheres would be, roughly, 370 pounds pressure per square inch.

Benton, in United States Patent No. 342,564, uses a pressure of 500 pounds per square inch, more or less—see line 82, page 1. He is cracking, in this case, crude petroleum.

Q. Please state whether or not, to your knowledge, the art, prior to 1907, disclosed a process of treating petroleum residues of the paraffin series, to increase the yield of volatile compounds above that normally obtainable therefrom, which consists in digesting the same in a confined state, under a pressure not in excess of 4 atmospheres, and not exceeding 400 pounds per square inch, such pressure being principally autogenous and at a temperature in excess of 200 degrees Centigrade, for a time sufficiently long to induce transformation of the major portions of said material treated, into more volatile products, said temperature being below that point at which sufficient carbonization occurs to substantially interfere with such transformation, and such digesting being conducted with the material being continually treated to pressure, throughout the digesting period, of the evolved volatilized compounds, undiluted by added acquous vapors, and in which the pressure may then be relieved and the evolved volatilized compounds separated from the non-olatile compounds.

—. Laing, United States Patent No. 471,291, of March 22, 1892, describes such an operation, operating, as he states, at 80 pounds pressure per square inch, for the production of cracked products of lighter character.

This United States Patent of Laing's should be read in connection with his United States Patent No. 488,767, of December 27, 1892, which is concerned with, essentially, the same apparatus and process.

Benton, United States Patent No. 342,564, of May 25th, 1886, states that he prefers to use 500 pounds pressure. I

refer to line 82, page 1. But he also states that the pressure can be varied—on page 3, line 12. He holds the product in the coil under the high pressure, and then releases it into the tank, C.

Engler, in his article in the Journal of the American [fol. 250] Chemical Society, Vol. 15, pages 379 to 382, of 1893, uses 25 atmospheres, which would be about 370 pounds pressure, and at a temperature of 800 to 400 degrees Centigrade, which would be, as specified, in excess of a temperature of 200 degrees. He obtains petroleum, and under these conditions cracks a portion of it, increasing the yield thereby, of volatile compounds.

Q. Does the French Patent to Barbet, No. 322,265, "Petitioner's Exhibit No. 136," disclose a process in which the oil is digested at a pressure in excess of 4 atmospheres?

A. He uses 5 to 6 atmospheres in his cracking boiler, and gets volatile products from the petroleum.

Q. Considering the material in the still, does Barbet then release the pressure from this material, and separate the volatile from the nonvolatile materials?

A. He does. The vapors pass through the pipe, Z, into the column still, and the liquid through the exit Y, to the point 3, in the column still.

Q. Are volatile materials separated from the liquid materials of the liquid residue, sent to the column?

A. They are—that is the purpose of the treatment in the column still.

Q. In any of the patents that you have mentioned is the pressure in excess of 400 pounds per square inch?

The Master: In the learned disquisition of the patent, has Palmer told the art anything new, as to the derivatives of this process of decomposition and disintegrating the residues into volatile compounds? Has he pointed out anything that was not known before, in respect to the product, the etylene and acetylene series, and the benzine, tolulene, naphthalene and the methyl-hexmethylene series?

The Witness: I think not. I think that we have always gotten just these same materials, whether we have cracked according to Palmer's method, or cracked by Dewar & Redwood, or by even the old atmospheric cracking method, though the amounts of them would vary, of course, with the raw material used. If we want these products of the

naphthalene, tolulene and methyl-hexmethylene and benzol series, it is better, for example, to start with such oils as the Russian oils and California oils. If we want to avoid that, we would avoid those oils.

The Master: When he says, in enumerating the important features of his process, "When in the complete sep- [fol. 251] aration of the so-called cracking from the step of distilling"—does he mean separation, keeping a distinction between the two, or does he completely separate the two processes?

The Witness: I should say that in his specification and claims he seems to want to make a physical separation of the two processes, but in his figure, here, he joins the two together, and would operate them as if they were one.

The Master: There is no stoppage from the time the process begins until it ends?

The Witness: That is the way it would actually be carried out, though, from the reading of the specification you might think that there would be.

The Master: He does not first perform a cracking operation and then stop, and then begin a distilling process, does he? The distillation is continuous from the cracking process, is it not?

The Witness: I would say that that was the inference from the figure. It is the inference partly from the specification, but, on the other hand a part of the specification, and particularly the claim, deals with the holding of the material in a retort, as if it was a separate step,—as if it was a separate physical step, that he could carry on, one part this week and another part week after next.

The Master: It is just like cooking your oatmeal a certain longer time—putting it into your fireless cooker and letting it heat until it further digests in the cooker. Is that it?

The Witness: I don't believe he digests it any longer than other people, carrying out the cracking process in tanks, did.

The Master: These references you state were for the purpose of accomplishing the result that Palmer seeks to accomplish—were they?

The Witness: Yes, sir, and they carried out Palmer's process of digestion work, to accomplish that.

The Master: And by the same means—by high pressure and by high temperature?

The Witness: But particularly by high pressure, and in the case of Engler, he distilled it, possibly the following week.

The Master: This is a very learned patent.

The Witness: In this connection, in paper No. 19, of the file wrapper, there is a statement by the applicant, through [fol. 252] his attorney, in comparing it to the Riebeckshe patent. He says:

"The patent to the Riebeckshe Company, cited by the Examiner, is tacitly admitted by the Examiner, himself, to be a combined digesting and distilling process, and does not contemplate a pressure of over 6 atmospheres. As above stated, in applicant's process the steps of digesting and distilling are entirely separate, and the prevention of the distillation during the period of digesting is of vital importance, to procure the necessary transformation which applicant obtains."

The Master: While he states that they are separate, doesn't it appear that this description and the specification, and the apparatus show, that they are not continuous, one immediately following upon the other, being a matter of time of cooking it?

The Witness: I would say that the specification and the claims would imply that they were different in time.

The apparatus shown by the figure could be operated so that there would be a difference in time, but it would also be capable of being operated where there would be a continuous process.

The Master: What do you means by time—do you mean elapsed time, or different in sequence?

The Witness: One would be finished before the other began, at all.

Q. Have you read and do you understand the disclosures of patent to Clark, No. 1,129,034?

A. I have read it and I understand it.

Q. What do you understand to be the most characteristic feature of this patent?

A. The use of multiple stills and the use of vapor from one passing into a common header, and from that passing into a still which is just beginning to be operated upon.

Q. What do you mean by "multiple stills"?

A. They are a series of stills such as indicated in Fig. 1, by the apparatus, A. B. C, and D.

The Master: In parallel or in series?

The Witness: They are in parallel.

Q. Do you know of any disclosure in the art, prior to 1914, of such an arrangement of stills in parallel?

A. Yes, sir, there are a number of cases where stills were arranged in parallel.

For example, in "Petitioner's Exhibit No. 123," French patent to Kornfeld, we have a group of stills, five shown in the figure, which are arranged as a series of multiple converters or stills. In this particular case five being in parallel. We have in one of the quite old citations, "Petitioner's Exhibit No. 155," Bresson, French patent, No. 108,214, of May 29th, 1875, another disclosure of plurality of retorts operating in parallel.

Mr. Wiles: What patent is that? Will you please give the name?

Mr. Rauber: Bresson.

The Witness: Bresson, B-r-e-s-s-o-n.

A. (continued). In Petitioner's Exhibit No. 120, Intschick, Russian patent, No. 4,584 of 1890, we have again a series of parallel retorts, that is, retorts operated in parallel. The preferred number illustrated is five.

In Petitioner's Exhibit No. 124, French patent to Barbet, No. 380,282, we have a series of vertical stills operated in parallel, and can be operated under pressure of five to [fol. 253] six atmospheres. The series in this case is quite large, being 19 in the figure going with the patent.

In "Petitioner's Exhibit No. 156," French patent to Desouches, No. 343,390, of 1914, discloses a battery of stills operated in parallel and having a common header to receive the vapors and gases.

Q. You mentioned that the gases were used to build up a pressure in the stills of the series, do you find any disclosure of this idea in the art prior to 1914?

A. In Petitioner's Exhibit No. 103, United States patent to Dewar and Redwood, No. 419,931 of January 21st, 1890, we have such a disclosure, "The use of air or carbonic acid

gas, or other gas that cannot act chemically on the matter treated." I am reading from page 1, line 50.

Also, we have the same thing in Petitioner's Exhibit No. 107, Redwood's Treatise on Petroleum, 1896 Edition, page 320, in which air or carbonic acid gas or other gas under the required pressure is used. This is essentially the step you have mentioned.

Q. In the Dewar and Redwood process could the uncondensed gases from the condenser of the cracking stills, or one cracking still, be stored, and then re-used in the same manner as the air or carbonic dioxide mentioned by Dewar and Redwood?

A. Yes, I would understand that that would be included under his term, "Or other gas." Such a gas as this would be certainly excellently fitted for the purpose.

Q. Could the uncondensed gases from a pressure still condenser be stored at atmospheric pressure and then compressed and introduced into the still in this manner?

A. They could be so stirred and so introduced.

Q. Have you read and do you understand the disclosures of Cross patent, No. 1,423,500?

A. I have read and I understand this patent.

Q. What do you understand to be the most characteristic features of this patent to Cross, No. 1,423,500?

A. The passing of the oil through a heated zone into a vessel where it will have a reasonable time to re-act, that is to crack, into the constituents desired.

Q. Will you please compare the manner of heating the oil in the Cross patent with the manner of heating the oil in the French patent to Kittle, No. 417,532, "Petitioner's Exhibit No. 131"?

[fol. 254] A. In the Cross patent, No. 1,423,500, we have the coil of pipes carrying the oil to be cracked passing through the furnace and in direct contact with the hot furnace gases, from the burner, 27, of the figure.

In the Kittle citation, which you have mentioned, the coil carrying the petroleum to be cracked passes through and is heated by a bath of molten lead; the molten lead itself being heated by burning flames through the wall of an iron container.

The two processes, of course, have much in common, in that both are heated to the cracking temperatures, but the means of heating, which I understand, is the essence of your

question, is different in the two cases; one being direct by furnace gases and the other by means of molten metal.

Q. As far as the oil itself is concerned, you understand it is subjected to the same steps in heating in both cases?

A. Yes, and to approximately the same temperature.

Q. In the Cross process, as described in patent No. 1,423,500, what pressures are used?

A. The pressure of 750 pounds is given as a proper pressure. This is given for a typical oil to be cracked. This is given on page 1, line 101.

Q. In the art prior to——

A. (continued). It is also mentioned several times on page 2, line 70, line 84 and possibly elsewhere.

Q. In the art prior to 1918, do you find any disclosure of the use of pressures in the neighborhood of 750 pounds and the cracking of hydrocarbon oils?

A. In "Petitioner's Exhibit No. 231," Renard British patent, No. 3,413 of 1913, we have the mention of pressures of forty to fifty atmospheres. Fifty atmospheres would be 735 pounds, which is almost identical with the pressure of 750 pounds suggested by Cross.

In "Petitioner's Exhibit No. 144," Graeffe & Walther, British patent, No. 25,510, of 1913, is described the cracking of petroleum to obtain gasoline, and on page 2, line 43, they mention the use of pressures of twenty to fifty atmospheres. Fifty atmospheres would be, as I have said, a pressure almost exactly 735 pounds to the square inch.

In "Petitioner's Exhibit No. 122," Bacon, Brooks and Clark, United States patent, No. 1,131,309, we have also high pressures but not so high as in the Cross patent; a [fol. 255] pressure of 300 pounds to the square inch, being mentioned on page 1, line 26, and elsewhere.

Q. On page 1, lines 14 and 15 of the Renard British patent, No. 3,413 of 1913, there is a statement that the pressure maintained throughout the travel of the fluid being in excess of this vapor tension; what do you understand to be the purpose of this pressure?

A. To keep the liquid from boiling; that is, to keep the liquid from changing to a vapor or gas, though it is at high temperature.

Q. Is this also done in the Cross process of patent, No. 1,423,500?

A. Yes. Page 1, line 60:

"In the present invention, the oil to be heated, is fed continuously through a heating zone, subsequently through a continuous coil of pipe seated in a suitable furnace and there heated to the desired re-acting temperature. The oil, then in substantially liquid phase, is passed to a re-acting zone."

If it is in a liquid phase, it means that there is little or no gas present, so that we would understand here that there was substantially no gas or vapor present.

Q. Will you please describe and explain the development of the art of cracking hydrocarbons?

Mr. Clark: Might I suggest that the Examiner and witness are talking in very low tones this morning, and it is heard for us to hear them?

Mr. Rauber: Oh.

Q. Will you please describe and explain the development or history of the art of cracking hydrocarbons, or the pyrogenesis of hydrocarbons?

A. The pyrogenic decomposition of petroleum, with the consequent breaking up of the molecules and the production of both lighter and heavier hydrocarbons, is termed "cracking." Commercially, the principal object of the process known as cracking is, by this pyrogenesis or heat treatment, to subdivide or split up the molecules of the hydrocarbon oils and to rearrange the relations between the carbon and hydrogen atoms, so as to obtain products having lower boiling points. Whatever heavier hydrocarbons are formed as by-products are by the continued treatment, recracked to get the more merchantable lower boiling products, such as gasoline and kerosene.

Prior to the dates of the patents in suit, say prior to [fol. 256] 1905, the known steps by which low boiling hydrocarbons could and were made by cracking the heavier hydrocarbons were as follows:

Taking, first, the cracking at atmospheric pressure: The crude oil was first distilled in an atmospheric still to remove the gasoline and kerosene which were present in the crude oil as received. The heating was then changed from being a fairly rapid heat to a slow heating so that the rate of distillation would be slower and some sort of a partial

condenser or run-back or reflux or dephlegamator (these words all mean the same) was used.

This partial condensing in the early days was by exposing the top of the still to the cooling effect of the outside air. Later, even the upper part of the sides were exposed as well. The effect of this exposed portion was to partially cool the vapors, permitting them to condense as liquid and drop back as liquid drops, or in a small stream running down the side of the still into the heated oil which was being cracked. The distillate would come over gradually, the process being a long one when carried out at atmospheric pressure, and the resulting product, condensed in condensers using atmospheric pressure by means of a condensing coil with cooling water external to the condensing coil. The resulting product, which had been divided as it came over into two or three or more tanks, according to the gravity of the product at the time it was flowing out from the condenser, that is the light gravity product going to the gasoline tank, the medium to the kerosene and the still heavier to an impure kerosene, or sometimes to a tank for oil for other purposes; the resulting products then were the crude gasoline and kerosene. There were purified by stirring up with sulphuric acid, then ordinarily that acid was drawn off, then shaken and stirred again with an additional quantity of sulphuric acid, and possibly the acid treatment repeated for a third time. It was then washed with water to remove the bulk of the acid which could not be drawn off from the bottom of the tank, then washed with a caustic soda solution, then washed with water, allowed to stand before the final settling out of the water, and either sold directly after this treatment or in some cases redistilled in order to get a perfectly clear liquid or higher grade gasoline or kerosene, as the case may be.

The Master: Which was called waterwhite?

[fol. 257] The Witness: Water white is not quite that good. It may be; it was at one period but it is not at present.

A. (continued). In the case where pressure was used we would have the distillation carried out either with the same kind of an apparatus as has been suggested for at-

mospheric distillation, but under some pressure, or better still, an apparatus in which the partial condenser was under better control, so far as temperature regulation, than the use simply of air cooling as that type of still would be.

As pressure was to be used the still would probably take the form of a piece of apparatus that would readily withstand pressure, such for example, as a pipe like still of small or even of considerable diameter. The condensation, when using a pressure still, could be either under the same pressure as the still with a valve at the end of the condensing apparatus or its receiving tank, or it could be, and sometimes was, particularly when operating for kerosene, at a point between the cracking still and its reflux condenser and the final condenser, which would condense the lighter products, gasoline or kerosene.

In some cases no reflux or partial condenser was used and we would have the vapors from the cracking still under pressure distilling out and being condensed, and then that product being redistilled in a separate still under atmospheric pressure.

In other words, the gasoline and kerosene desired have been made in a cracking still by the cracking process, separated from the residuum, by passing into the vapor form and being transferred to the condenser and there condensed, and then this condensate redistilled and separated into its several fractions.

The resulting product would then be purified by sulphuric acid, water, alkali, and water washes successively, just as in the case of the product from the atmospheric cracking process.

I may add, that other schemes for chemical treatment besides sulphuric acid, alkali and water were used from time to time, but only in minor amounts due to the fact that they ordinarily use more expensive chemicals than sulphuric acid and caustic soda.

I wish now to pass to what may be said to be a chronological discussion of the process of cracking, as we have been concerned with it here this past week. First, I wish to give [fol. 258] a few words regarding the early, general scientific knowledge which bears upon cracking processes.

It has long been known that the use of vacuum lowers the boiling point of liquids, and also that the use of pres-

sure increases the boiling point of liquids; for example, it takes a certain temperature to cook an egg, and yet we find that we can not reach that temperature, say, on the top of Pike's Peak, i. e., we can not cook an egg by boiling it in water on the top of Pike's Peak, if we do it at the low atmospheric pressure there. On the other hand, we are all familiar with the fact that water boils higher under pressure as in the ordinary steam boiler, where it has to be treated considerably above 212 degrees if we are going to get steam at a pressure of, say 150 pounds pressure per square inch.

What is true of water is true of liquids in general. Decomposition of chemical compounds is decreased by handling them at lower temperatures, and, accordingly, distillation of a material in a vacuum permits that product to be handled with less decomposition than if it is carried out at atmospheric pressure.

A good illustration of it is in the manufacture of ordinary granulated sugar. The sugar syrup is evaporated in a vacuum, and, accordingly, we can get out from this process nearly pure sugar, such for example, as ordinary granulated sugar.

On the other hand, if we evaporated this same, or a similiar, sugar solution at atmospheric temperature, we get a dark brown sugar, such as our grandmothers used. The difference is simply that in one case the sugar is partially decomposed due to the high temperature, whereas, in the case of the vacuum that decomposition is prevented to a considerable extent.

The use of pressure, as we have said, increases boiling point, and accordingly, we would expect it to increase the decomposition of material which is likely to decompose.

Using the term "decomposition" in the pleasant sense (rather than in an unpleasant sense), that is as cooking of meat, we would have here the reason why meat which is canned is heated under a steam pressure of considerably above atmospheric pressure in order that the changes in the meat, which we commonly know as cooking and which correspond in every respect to the decompositions that I have spoken of, of other chemical products, can take place [fol. 259] quickly, and so that we can have from a given apparatus a large output per day.

Each 20 degrees Fahrenheit rise of temperature ordinarily means a doubling of the speed of a chemical change. This is not a universal rule, there are a few reactions which increase faster than this, particularly some of those which are related to our explosive materials.

A fifth item to our general scientific knowledge which bears upon cracking, is the fact that increased time at the high temperature increases the extent of the chemical reactions, that is decompositions, which would take place in small amount in a less time.

A sixth fact which comes in here is the fact that the hydrocarbons with which we were most familiar in those times, and indeed still are at the present time, were those of the paraffin series. The word "paraffin" means "with little affinity"—that is, that were not readily reacted upon by chemicals—and our ordinary method of purifying a mixture carrying paraffins and other hydrocarbons is to change the other hydrocarbons by severe chemical treatment, which chemical treatment even though severe is essentially without effect upon the paraffin hydrocarbons. These are also known not only as paraffin hydrocarbons and as saturated hydrocarbons, but as hydrocarbons of the methane series and by some other less used terms. The meaning is the same, though, in each case.

The seventh item which bears upon the general scientific knowledge, which is of importance for us to have as a basis here, is the known fact of the use of a still and a condenser for separation of the constituents of a mixture. That is, this will permit us to separate, for example, water from sugar; that is a liquid from a non-volatile solid, or it will permit the separation of the alcohol from the water of a fermented liquor; it will permit the separation of two liquids which are generally quite similar but which differ only in boiling point. As the process depends upon the difference of boiling point as the basis for the separations accomplished by use of a still and a condenser, we can, accordingly, take a crude oil, and by running it through a still and condenser separate out the low boiling materials, such as gasoline; then, as the temperature of the still gets higher, the kerosene portion will come over, and as it gets still higher, the gas oil, and so on.

Coming, now, to the petroleum industry, the first step upon which our present industry of cracking of petroleum

depends, was the disproof, in the winter of 1861-2, at New [fol. 260] ark, New Jersey, of the, up to that time, generally accepted belief that the saturated hydrocarbons, that is, the paraffin hydrocarbons of petroleum oils were stable towards heat.

It has been known that they were stable towards chemicals and it had been presumed that they were stable towards heat.

The discovery of their lack of stability towards heat was due, it is said, to a workman in a refinery at Newark, New Jersey, finding that his still charge was nearing completeness and that the amount of oil distilling over from this charge was getting less, and from the gravity which it had reached, and from the amount which had already come over, he thought that it would be completed in the course of a few hours. He arranged his coal fire under the still and went away, expecting to be back, say in half an hour, but was detained. Rumor says he had a fit and did not recover from it for some three hours and then came back to the still and found, to his surprise, that the gravity of the oil which was passing over from the outlet of the condenser, was no longer the heavy oil which was coming out of the condenser when he left it, and which he expected to get heavier and heavier, but instead it was a lighter oil.

He watched it for a few minutes and it was still the lighter oil, of kerosene type, and then he went to see the superintendent, to tell him what had happened, and the superintendent came there, and being, himself, a man of some training in chemistry, he saw, at once, that the process was giving him and would give him a larger yield of kerosene. In fact, on their return, say twenty minutes, later, the product was of still lighter gravity than it had been when the workman found it, after his three hours absence.

From that time on this superintendent carried out the distillation essentially in the same way, and thereby approximately doubled his yield of kerosene from a given charge of crude oil.

Thinking over the process he decided that it could be improved, and the rate of distillation speeded up, for it must be borne in mind that the rate, when carried out in the original still, was very slow, and, in fact, in some cases,

was as long as two weeks for this slow atmospheric cracking.

In order to speed up the process he exposed more of the still covering, or top, and, indeed, later, part of the sides, to the atmosphere, thereby increasing the amount of partial [fol. 261] condensation, or run-back, and thereby approximately halved the time of the time of the cracking process. That is, he reduced it to, say one week's time.

We have at the Newark plant, then, the first cracking—the first use of a run-back—an extended use of the run-back, or partial condensation, and then the increase of the amount of this partial condensation, by the increase of the exposure, particularly the portions of the still above the liquid level of the liquid in the still.

In other words, the operator was trying to keep the liquid as hot as possible, and yet have only a minor amount distilled over, out from the still into the condenser.

This process, which had been worked out by the Newark refinery, was scarcely one which could be kept as a secret process. It was not patented and in the course of a few years—in the course of, perhaps, even of a single year, was in use by practically all the oil refineries of the country.

It also came to be in use in the oil refineries of Europe.

We have, in "Petitioner's Exhibit No. 118," the article by Aisinman, on the Cracking of Petroleum, of 1900, in which there is a general discussion of the history of the early cracking work, particularly that of Europe. However, he gives the credit, as he should, to the Newark, New Jersey work, as the beginning of the cracking knowledge.

The differences of the early cracking stills were largely differences in character of the schemes used for partial condensation, or run-back, or reflux apparatus, as we may call it, and Aisinman illustrates several types of these, in his article.

Furthermore, Aisinman describes, in some detail, the oil obtained from atmospheric cracking.

We do not have, so far as I recall at this time, any detailed description of the cracked oil obtained at Newark or in the other refineries of America, during these first years. The product was mixed with the straight-run distillate, and little attention was paid to any distinguishing characteristics which it might have.

The next step in the history of the cracking process is given by "Petitioner's Exhibit No. 93," Young's British Patent of 1865, which is the first use of pressure in a still used for cracking.

Young uses a pressure of 20 pounds, in his cracking still. This would mean approximately doubling the speed of cracking, over what would be had in an atmospheric still.

He recognizes the dangers in the use of pressure when we have a volatile and inflammable liquid, such as petroleum, and consequently he suggests that the still must "be [fol. 262] made of sufficient strength to resist a pressure of at least 100 pounds to the square inch."

He further states that the oil contained in the still is "thereby converted into vapor, which may be allowed to pass to the condenser under any desired pressure, and such pressure may be regulated by means of a valve loaded to the extent of pressure required."

He also suggests the use of pressure gauges in controlling the apparatus, and some other details, and in this connection I might call attention that the handling of petroleum under pressure, in cracking operation, has largely followed, so far as pressure is concerned, the apparatus available from other industries, for pressure handling.

And in particular I refer to the question of steam boilers. Steam boilers were early used, having a low pressure. As I recall it, the steam boiler which Watt used for his first steam engines of commercial character, was 35 pounds pressure. By Young's time, 1865, boilers were normally in use, carrying about 75 pounds pressure, and we have an increase of pressure, as we know more about steel, and particularly the use of better steels, until twenty years ago boilers were normally sold for pressures of 125 or 150 pounds. Today the ordinary boiler, as sold—I am speaking, in each case, of the larger commercial boilers—will carry 300 or perhaps even 400 pounds pressure. And we have a few boilers which are being used, which carry higher pressures—up as high, now, as a thousand or twelve hundred pounds, and I know of one, which is, to be sure, possibly considered only as an experimental boiler, that, within the last year has been carrying something like three thousand pounds per square inch pressure.

Young states—and I read from page 3, from line 25 on—"The apparatus employed may be of various forms, but I

have found that an ordinary steam boiler, not tubular, answers the purpose that we speak of. The more capable it is of being easily cleaned the better, as the heavy deposits should be removed therefrom, at intervals."

Following Young's patent—and it must be borne in mind that Young was from the section of the Scotch shale oil plants, and, in fact, from the same county, and probably was active in that industry,—following this work of Young we have some university work, carried out by two men from the University of Glasgow.

The shale oil plants in Scotland are but a short distance from Glasgow—in fact, just outside the city of Glasgow, and in the direction of Edinburgh.

"Petitioner's Exhibit No. 94," Thorpe & Young, 1871, and "Petitioner's Exhibit No. 95," Thorpe & Young, 1872, [fol. 263] and "Exhibit No. 96," Thorpe & Young, 1872, describes this work out at Glasgow, at the University.

The Master: Is that Young the same man that has been referred to before?

The Witness: I think not. It isn't the same Young. It is James and John Young, but I have been told this was a son. But I have not been able to verify that.

Thorpe was a professor of chemistry, and Young was a student, or an assistant in his laboratory.

Thorpe & Young cracked by the process of Young's patent, paraffin wax, which was a typical saturated hydrocarbon, readily obtained in apparently pure form, and a material which could be easily duplicated by us.

They cracked this paraffin, by, as I have said, Young's process, varying the pressure slightly, using from 20 to 25 pounds, instead of a limit of 20 pounds.

That is, we have here, a beginning of the increase of pressure for cracking purposes. They found that the cracked paraffin, which was cracked by slow distillation, at 20 to 25 pounds pressure, gave several products, and being men who were approaching this matter from the scientific side, they described accurately and carefully the products obtained.

From their work we find, for example, that from four litres of product they obtained one and three-tenths litres of a product boiling below 200 degrees Centigrade, which would be 392 degrees Fahrenheit. This is a product well

below the boiling point of the present-day gasoline—437 degrees Fahrenheit.

Or, in other words, they obtained from the three and a half kilograms of paraffin, which was almost four litres when melted—they obtained one and three-tenths litres—that is, a 33 per cent yield of gasoline.

The remainder of the product was essentially kerosene. So that we have here, as they started with a nearly pure product—that is, almost 100 per cent successful cracking of a saturated hydrocarbon—that is, the paraffin wax, to give gasoline and kerosene, with almost no by-products, or residues.

In my knowledge of the literature, I don't recall any later worker on cracking, who has ever obtained anything like this completeness,—that is, a hundred per cent cracking, as was obtained by Thorpe and Young in 1871—without the production of anything but the desired products, gasoline and kerosene.

They also show that the residues from this pressure recracking—in another experiment—could be recracked, and we have, then, the additional disclosure here, of the recracking of residues from the previous cracking process.

[fol. 264] They refined the cracked products obtained by a scheme which could scarcely be used commercially, but which was common, and is still common, in the refining by hydrocarbons, by university research workers. They distilled the product over sodium—metallic sodium,—which is a very active chemical, and would act on the impurities of most kinds, such, for example, as the resinifying products. It will bring about a change in those products, into resins, which will then not distill, following this process by distilling.

In other words, they heated this crude gasoline and kerosene with metallic sodium, and under those conditions, I may add, metallic sodium will melt so that it will bring the liquid metallic sodium into contact with the liquid hydrocarbons, and the sodium will re act with impurities, leaving a fairly pure mixture of hydrocarbons.

The Master: There is a mention in some one of these patents of catalysis. Is that a catalyzer?

The Witness: When sodium is acting upon products of the diolefine types—that is, where you have two double volumes—we count it as a catalytic agent, because, by so doing

we can make artificial rubber, and the final product has no sodium in it.

The time may come, indeed, when the use of sodium on certain cracked products from petroleum, may give us a supply of rubber.

The sodium, however, re-acts on other impurities, directly, chemically, and without it—without catalyzation. In this treatment I think it probably acts both as a catalytic agent and as an ordinary chemical should.

The product, after the sodium treatment, was distilled, and the distillation carried out very carefully, in order to get the individual constituents, and to be able to identify them so they could put labels upon them.

They found that by this cracking process they obtained mixtures boiling at various temperatures, from which they were able to isolate the individual pure compounds.

Without going into the details, as to just how this was done, I might say that they proved the presence in the gasolene, of the hydrocarbons, which we know as pentane, hexane, heptane, octane and nonane. These, you will note, are named from the number of carbon atoms in them—pentane having five carbon atoms, hexane six, and so on.

These are the same hydrocarbons which are present in largest amount in, for example, the straight run atmospheric distillation gasoline, obtained from Pennsylvania crude oil.

They are also present in gasolines obtained from other crude oils.

[fol. 265] In addition to these they found present corresponding unsaturated, or olefinic hydrocarbons, hexylene, hepthalene, octolene and nonelene. And, furthermore, they found that the percentages were quite large, of these unsaturated hydrocarbons, the percentages being generally in the range of 40 to 45 per cent of the total volume boiling within any particular range.

These olefinic hydrocarbons, such as I have mentioned—hexylene, hepthalene, and so on, are present in straight run gasoline made from crude oil by atmospheric distillation, only in very minor amounts. In fact, in some cases it is questioned whether they are present, at all, in the crude oil, but whether they are, or not, is due to slight cracking of the crude oil during the simple distillation.

Similarly, Thorpe & Young examined the kerosene, though not in such great detail.

I may add that the gasoline which they describe is essentially the same as that described by Ellis, in the product patent in suit.

I now pass to work of slightly different character.

The uses of gasoline in the period of 1860, to—well, for more than the next 20 years—were largely those connected with the carbureting of gas—that is, the giving to gas a higher illuminating and heat value. Illuminating gas was carbureted, for example, by bubbling it through gasoline. Illuminating gas was also actually made, and is even yet made, to a small extent, for isolated buildings, by bubbling air through gasoline. We must, for this purpose, have a very highly volatile gasoline. Such gas will have high heat value, and it will have a high illuminating value. At this date we were burning gas from flat wing tip burners. Welsbach mantles had not yet come into general use.

It was found, by several men, that they could get higher illuminating value in the gas, if, instead of using ordinary gasoline—which was largely straight run gasoline at that time—by using certain other materials.

For example, "Petitioner's Exhibit No. 109" Boynton, 1886, carburets the gas by bubbling it through a mixed liquid. The liquid used is a synthetic gasoline, which would meet the specification disclosed by Ellis, in his product patent, in suit, No. 1,318,060.

The liquid used he obtained by mixing the distillate from coal tar—that is, crude benzol from gas tar—and ordinary gasoline, and then he distills them and takes the portion boiling below 350 degrees Fahrenheit. Such a distillate would carry considerable benzol, and other unsaturated [fol. 266] products, and these are materials which add greatly to the illuminating power of gas.

So that, by carbureting gas of such a synthetic gasoline, he would obtain a much higher candle power in his gas.

"Petitioner's Exhibit No. 110," Bassett, 1867, describes another synthetic gasoline, which would meet the disclosures of Ellis product patent, No. 1,318,060, where he uses a mixture of petroleum-like distillate of 79 degrees Baume, which would be a very volatile gasoline, with a coal distillate of 28 to 30 degrees Baume, which would

carry considerable amount of benzol and toluol, and uses this mixture in carbureting the gas.

In "Petitioner's Exhibit No. 111," Walker, 1910—and I speak of this out of order, because it is closely related to these two others, which I have just discussed—makes a novel solvent by treating gas naphtha from cracked American petroleum with hydrochloric acid, and the product is a primary olefine oxide.

Incidentally he describes the gas naphtha, as he calls it, made by the cracking of American petroleum, and states that it contains 40 per cent of olefines, and only 60 per cent of paraffins. Its boiling point ranges from 35 degrees Centigrade to 125 degrees Centigrade. These temperatures would be 95 degrees Fahrenheit to 257 degrees Fahrenheit—a boiling range well within the gasoline range.

The Master: That is five years after the date of 1905, to which you are confining your resume of the state of the art?

The Witness: No, your Honor. That early work, there, was in connection with the atmospheric cracking, not on the historical side. I am going through it and bring it clear up to that, if I can.

Such a product would represent the modern cracked gasoline.

"Petitioner's Exhibit No. 108," Spear's, 1870, makes the gasoline fraction from petroleum distillation, and the tar residue left on distilling petroleum, and re-distills again, after separating out the dirt.

His process is for the production of a hydrocarbon oil for illuminating and other purposes. This is, again, a product of somewhat cracked character.

We go, now, to the question of the apparatus and process development.

Petitioner's Exhibit 126, Warden United States Patent of 1871, discloses a vertical still, and it is to be noted there that this still is like a number of those which came in more than a generation later, in that in the vertical still only the intermediate portion is heated, that is the ends containing [fol. 267] the liquid portions are left unheated. Moreover, he draws off carbon from the bottom and it is the earliest of our citations which has a scheme for carbon removal; and, further, that he pre-heats the oil fed to the still. He seems to recognize well the principles of heat economy, as well as the fact of carbon formation in cracking or in dis-

tillation and partial cracking, and to have taken reasonable and quite good means to handle these phases of the operation. He does not state whether the still is worked under atmospheric pressure or under a superatmospheric pressure.

Petitioner's Exhibit 155, Bresson, French Patent of 1875; This exhibit discloses a plurality of retorts in parallel; the use of higher temperature; in fact a temperature of red heat; the use only of atmospheric pressure with such high temperature and the re-use of the heavy oils which were uncracked earlier by the first passage.

One other disclosure he makes is of considerable importance: In the partial condenser or run-back which he uses, he cools to an exact temperature. He uses for this partial condenser an ordinary type of fire tube steam boiler, by passing the vapors through the boiler he regulates the temperature or condensation by the temperature of the steam pressure; that is, with the boiler being kept at 75 pounds pressure per square inch, he thereby chills quite accurately in this partial condenser, the vapors to a temperature of 152 degrees Centigrade, which would be 306 Fahrenheit.

This is the first case we have of an accurate temperature control of the run-back or partial condenser.

Petitioner's Exhibit 113, an article by Allen in the scientific magazine called The Analyst in 1881, describes, in considerable detail, "the representative commercial products" on the English market. He gives the gravity and bromine number of a number of these commercial products of 1880 and 1881. Here it is shown that the shale gasolines of commercial character are highly unsaturated, that is, they are like present day American gasolines. The bromine number is given as 67.1 in one case, and 94.9 in another case. It is to be noted also that even the gasoline from well petroleum, which presumably was not obtained from any process primarily for cracking, has a bromine number of 5.1 and another lot 10.0, showing that even the straight run gasolines of 1880 and 1881 carried considerable percentages of unsaturated compounds.

Furthermore, the gravities and bromine numbers, that is the gravities and a measure of the degree of unsaturatedness, are given for what he calls "the burning oils" but which at the present day we would call kerosene. These [fol. 268] are shown to have, when made from shale, brom-

ine numbers of from 36.4 to 38.7; and when made from petroleum by straight distillation, 17.2. A product without unsaturated hydrocarbons as a constituent would have a bromine number of zero.

Chronologically, our next item is Petitioner's Exhibit 114, an article by Williams in The Chemical News of 1884. He shows that when petroleum is cracked at a high temperature, such as is used in making gas by the Pintsch system, there is a by-product of low boiling point containing benzene, toluene and certain olefines. The samples varied from 24.6 per cent to 65.6 of benzene and toluene, the rest being largely olefines. Such a product is one which could be sold as modern gasoline.

Petitioner's Exhibit 119, Armstrong & Miller, 1886, discusses the use, in the refining of a hydrocarbon condensate, of dilute sulphuric acid, and shows that 76 per cent sulphuric acid works in refining of the hydrocarbon condensate.

Petitioner's Exhibit 150, Benton, United States Patent of 1886, describes a cracking apparatus operating at higher pressure than we have had mentioned hitherto and at somewhat higher temperature as well. The temperature used is from 700 to 1,000 degrees Fahrenheit; the pressure used, 500 pounds per square inch; and in addition he is the earliest of the citations to use a continuous process.

It is to be noted that he operates under conditions where there is no vapor set free until the pressure is released. He speaks of digesting in his cracking vessel which, in this particular case, is a steel coil.

Whenever we deal with the history of petroleum cracking, this patent of Benton is almost always mentioned, he being the first to propose a continuous process; the first to use a high pressure (a pressure of 500 pounds), and one of the first to use relatively high temperatures, a thousand degrees Fahrenheit. Also he was, I believe, the first to use a coil as a heating unit.

The Master: Without interrupting your question, and you may go on later on, but the hour of twelve-thirty having arrived, and desiring to summarize this whole testimony thus far, I would like to ask you:

Prior to 1905, was the art informed as to the presence in hydrocarbon oils of the paraffin and olfine groups of varying proportion and relation of hydrogen atoms to carbon

atoms; of the distinction between the saturated and unsaturated groups; of the nature of the ethlene and acetylene series, and likewise of the benzene, toluene, naphthalene, [fol. 269] anthracene groups and the manner in which all of them and their derivatives could be segregated by pyrogenesis.

The Witness: The answer is "yes" to the first three-fourths of it without qualification.

The benzene, antharcene and naphthalene products were not known to be in the crude petroleum, and even at the present day they are considered to be absent from most crude petroleums. They are not formed, excepting the lower boiling ones, benzene, toluene, in any considerable amount, and in fact I do not recall that we have ever obtained any anthracene from petroleum. It is possible that we may have.

The Master: In so far as you have answered the question, not only was the presence and distinction between these various groups representing the varying combinations of carbon and hydrogen known, but was it known that the major steps to accomplish a separation of these were (a) disintegration by heat and pressure; (b) digestion to carry this integration to completion; (c) dephlegamation to separate; and, (d) condensation to transform vapors into liquod?

The Witness: These were all known——

The Master: As the major step?

The Witness: No.

Will you read the question?

(Question repeated by the reporter.)

The Witness: These materials were known to be present in the crude petroleum, and as such they could be obtained from the crude petroleum by simple distillation, the lower ones even at atmospheric distillation, the higher ones by distillation using a vacuum. So that, in order to get them, it was not necessary to use any pyrogenic process or cracking process of any kind. The pyrogenic process came in when we wanted to increase the amount present of the low boiling ones at the sacrifice of those which were higher boiling.

The Master: And that came in sometime about the time of the Young experiment, if it may be called an experiment, and Thorpe and Young?

The Witness: It came in in the Newark.

The Master: And Newark?

The Witness: Yes.

[fol. 270] Continuing my answer relative to the historical phases as illustrated by the citations of the prior art, which have been introduced, I will say that the next step is covered by Petitioner's Exhibit No. 97, the Reibeck patent of 1886. This discloses pressure cracking at two to six atmospheres and recommends, particularly for petroleum, two to four atmospheres. It carries a definite statement of preferred temperature, 750 degrees Fahrenheit, and, unlike most of the earlier patents and earlier citations, it describes in some detail the product formed and the residue left.

Petitioner's Exhibit No. 120, being an article by Cabot in 1887, proves the presence of Benzol in the condensate from highly cracked petroleum used in the process of gas manufacture. This becomes of importance only because it is a description of a process which, at one stage, would give the unsaturated hydrocarbons of the type of Ellis' product.

I come now to a group of six citations concerned with Engler's work, which chronologically, are "Petitioner's Exhibits Nos. 99, 153, 101, 98, 100, 152, being from 1888 to 1909.

In this work, Engler, a chemist of international repute at that time, was studying particularly the origin of petroleum. He considered that it might well be from marine deposits and that it might be from fish from prehistoric times. In a study of this he distills fish oil, or rather has distilled for him by the Reibeck Company, fish oil at from four to ten atmospheres. He also takes a portion of that which was not sufficiently changed by a single cracking process and re-distills it. He analyzes carefully the products made and finds that they are without question the same as those found in ordinary well petroleum. He proves, for example, the presence of the olefines in the low boiling gasoline product, and as well in the high boiling distillates and in the residues. He states that the products, in the first article, contained from 20 to 37 per cent of olefines; in the later articles, as some other writers had criticized his analysis as being by a method which would give low results, he re-works these and shows that they

do, in some cases, carry higher percentages of unsaturated compounds, that is of olefines; and in 1897 shows that the light distillate carries even forty-four per cent olefines.

He identifies positively the various constituents of this distillate by isolating them and getting their chemical products. I think there can be no question but what he has completely shown that the product obtained by his cracking process was like petroleum in so many ways that it can be considered petroleum, and, in fact, would be considered petroleum by anyone who had simply these products given to him for analysis.

In later work, in 1909, he uses still higher cracking temperatures, using pressures of from 10 to 25 atmospheres and gets the same types of products.

With these citations of Engler should be connected the one citation by Lobry de Bruyn of 1895, same being "Petitioner's Exhibit 151." This is a lecture experiment in which Lobry de Bruyn digests fish oil under 15 atmospheres and gets petroleum and its cracked products. The citation is of interest as giving a method of carrying out the process rapidly so that it can be carried out in a single lecture period.

We now pass on to one of the most important exhibits in the list of patents. I refer to the Dewar & Redwood Patent of 1890, "Petitioner's Exhibit 103," and a portion from the work of Redwood's Treatise on Petroleum of 1896, "Petitioner's Exhibit 107." Here we have, by exceptionally competent men, a working out of a process of petroleum distillation. Dewar at this time was a professor at the University of Cambridge. Shortly after this he became the head of the Royal Institution, this being a chair which was earlier held by Sir Humphrey Davey, and later by Farraday. Redwood, on the other hand, was also a man of international standing, being probably England's greatest expert on petroleum.

Thees men showed pressure distillation, that is, distillation under considerable pressures; they condensed under [fol. 271] pressure, and it is to be noted that they quote their reasons for doing so.

I wish to quote from line 44, page 1, of "Petitioner's Exhibit 103":

"Our invention relates to a method of conducting the distillation by suitable apparatus in such a manner that

we get the benefit of regular vaporization and condensation under high pressure, and that we may at the same time get such advantage as can be obtained from cracking."

I quote this phrase of "regular vaporization and condensation" because it was used apparently in the same sense that Laing had discussed in the citation which we have mentioned earlier; that is, with the use of valves between the condenser and the cracking unit there was likely to be irregular puffs of vapor passing the valves and thereby making condensation and vaporization in the still irregular.

It is to be noted, further, that these men recognized the likeness of well petroleum and petroleum made from shale; that is, they count them as equivalent for cracking. I refer particularly to page 1 beginning with line 20 of "Petitioner's Exhibit 103."

They also show that the process can be operated continuously by using a number of retorts in series. I refer particularly to page 2, lines beginning with line 21.

They operate by charging the condenser, a space in the reflux and above the liquid in the retort with gas, which cannot act chemically on the oil, and thereby they get the effect of pressure at the start of the operation, where otherwise, they would have, at the start of the operation, simply straight distillation. This permits the better operation from the cracking process. If there was not this introduction of gas at the start, we would have at first a simple distillation and products going over, which would be of undesired character.

The next step of importance is made not in England and United States but in the Russian patent to Intschick, being "Petitioner's Exhibit No. 120," and carrying a date of 1890. We have here the disclosure of vertical pipe retort, a series of multiple retorts set in parallel or in series, both being described, a vertical retort heated intermediate at the ends; a vertical retort heated highly (that is as a vapor phase); a vertical retort with schemes for mechanical removal of carbon, and a retort permitting gravity removal of carbon; and retorts which are used without pressure or with pressure.

[fol. 272] Following this closely we have "Petitioner's Exhibit No. 129," the Schuchow & Gavrilow Russian patent of 1891, in which we have multiple heating coils, multiple vertical stills of straight character; the use of decided pressure; the recracking of the residue; the use of superheated feed, in order to save fuel in the cracking still itself; the use of a dome to separate the vapors from the uncracked product. This process is, in general, conducted at atmospheric pressure.

"Petitioner's Exhibits Nos. 133 and 134" are Pielsticker patents of 1891 and 1892. Here we have the cracking under pressure, cracking in a coil, cracking in a tank, the use of reflux apparatus of simple and of complex type, including a bubble tower, the pre-heating of oil, condensing under atmospheric pressure, the use of the process as a continuous process. He also describes a case where, instead of wishing liquid hydrocarbons, the material can be still further cracked to get gas products for enriching gas or any similar purpose.

The next group of exhibits are Exhibits Nos. 104, 105, and 106, Laing of 1892 and of 1894. In these we have (in the earliest one), a continuous process using a special, not very important for us, type of reflux, and using a low pressure of near atmospheric or say up to ten pounds.

In the next we have (I refer "in the next," to "Petitioner's Exhibit No. 104") the use of higher pressure, 80 pounds pressure, and with that comes an attempt to overcome the difficulties of pressure cracking, and, at the same time, atmospheric condensing. This is attempted by means of a special relief tank between the pressure still and the atmospheric condenser.

It is to be noted, in this connection, that the gravities of the raw and cracked oil are given and these are of some importance to us, because there are so many cases where in this earlier work the characteristics of the oil obtained are not indicated.

It is to be noted that, particularly in Exhibit No. 106, Laing brings out the real purpose of the pressure; that is, it has for its purpose the raising of the boiling point, and he compares clearly the advantages and disadvantages of pressure and atmospheric condensation of the cracked products.

It is further to be noted that Laing, in Fig. 2, being a part of Exhibit No. 106, gives a scale drawing, showing a still here of considerable size; a still which would hold approximately 2000 gallons.

[fol. 273] Possibly a comparison might be of interest in this connection: This would mean a still roughly twice the size, twice the capacity of the large street sprinkling tanks which we see on the streets of New York City. Two thousand gallons is not in any sense a laboratory outfit.

The next citation in point of time is "Petitioner's Exhibit No. 143;" Mann United States Patent of 1899. This Exhibit is of particular importance in connection with the Adams' hot-plate scheme of cracking. Mann recommends cracking at 800 degrees Fahrenheit, at fifty pounds pressure, with a heated metal shelf as the cracking surface, and he further uses a metal shelf over the bottom of this first metal shelf; that is, a second piece of metal over the bottom of the still. He injects the petroleum as a spray, and further suggests that he may use steam in carrying out the process. He condenses at atmospheric pressure, the valve which he uses being a not particularly efficient valve, that is, a valve which might or would probably give some trouble in the way of irregular spurts of vapor.

"Petitioner's Exhibit No. 121," Lennard of 1900, is primarily of importance on account of the character of the scraper, which he describes in detail; a scraper for removing the carbon from the walls of the retort. It is to be further noticed that this is not only a mechanical scraper, but that it is a rotary scraper.

"Petitioner's Exhibit No. 102," Kraemer & Spilker, in a German Magazine of Berichte, 1900, crack pure organic compounds at pressures of ten and at twenty-five atmospheres in order to show the exact nature of the cracking process. They further crack Russian oil and thereby get increased olefines, as shown by the bromine numbers obtained. The fraction, for example, of the gasoline, had a bromine number corresponding to about seventy-five, which would correspond to an iodine number of about 120, provided, we make no correction for gravity, the gravity of the particular product not being given. This gravity correction would not be great, though. He also cracks rosin oil, that is the product after ordinary rosin has been partially decomposed.

[fol. 274] "Petitioner's Exhibit 116," Redwood's Treatise on Petroleum, Vol. 2, of 1900, we have disclosed the use of dilute sulphuric acid for the treating of petroleum distillates.

"Petitioner's Exhibit 127," Gaster, being British patent of 1901, describes in great detail a rotary scraper to remove carbon from walls of a vertical still, and he also arranges that this shall fall as a sludge to a chamber beneath. Gaster is concerned more with carbon removal than pressure, but shows that carbon will fall as well under pressure as when at atmospheric pressure.

"Petitioner's Exhibit 123," Kornfield of 1902, discloses a number of things which are of importance; the vertical retort; the vertical retort used in multiple; carbon removed by a scraper; retorts heated intermediate their ends; stills under pressure; a regulating needle valve between the pressure stills and the condenser: this permitting even running of the vapors from the cracking still to the condenser. It is also to be noted that Kornfield's is a liquid phase cracking process and apparatus for same, rather than vapor phase.

"Petitioner's Exhibit No. 117," Vittenet, French Patent of 1903, discloses the washing of gasoline with seventy-eight per cent sulphuric acid, and then following it with sodium acid sulphite solution. This is of interest in connection with the Ellis process patent.

I now come to a group of Barbet exhibits, being "Exhibits Nos. 136, 141, 124, 125, 139, 137, 138 and 140," and, in the order given, running from 1903 to 1911.

A few words regarding Barbet, at this point, may not be amiss.

Barbet was, and possibly, if he is living still, is still the world's greatest designer of distilling apparatus. He is, probably, the highest authority in the way of column stills that the world has ever produced, and we have, here, in connection with his general work on distillation, the application of some of his knowledge to the petroleum industry.

We have in the earlier ones of these citations, attention directed to the use of pressures of five to six atmospheres [fol. 275] in the cracking still, the use of a continuous still for the crude oil, the cracking of the residues continuously,

the pre-heating of the oil feed, the vapors and liquid removed separately from the still to bubble tower, and the use of a multiple shelf bubble tower.

In citation, 124, we have the use of vertical stills instead of the tank-like still in the earlier work, and in such case he heats the stills intermediate their ends, has a receiver at the bottom for any settlings of carbon and other such material, and re-cracks the portion uncracked by the first treatment.

In citation, 129, he uses a lead cracking bath and connects it to a bubble tower and runback, of the types which we have described earlier.

We finally have him describing the apparatus which would come very near being a complete refining outfit, where we have a continuous still for the petroleum, an internally cooled bubble tower, various schemes for fuel economy, such as the preheating of the feed and the distillation, after chemical treatment, and schemes for chemical treatment.

In "Petitioner's Exhibit No. 156," French Patent to Dessouches, of 1904, we have a battery of stills with a common header into which the vapors go, and the heating of the liquid by means of pipes which pass through the oil.

"Petitioner's Exhibits No. 154," describes the Nikiforoff process—though here it is spelled with "w" as the last letter—by which, from Russian oil, benzol was obtained by cracking. The cracking was carried out at two atmospheres pressure, and there is some description of the various products in the way of specific gravity, given.

It is to be noted that in this case a particular fraction is the only fraction which is re-worked.

I should have given, earlier than this, the "Petitioner's Exhibit No. 149," instead of the patent to Nikioroff, above of 1904. He distills and cracks at 500 degrees and above; the distillate below 200 degrees, is then re-cracked to get benzol, using a pressure of 15 pounds per square inch, or higher.

"Petitioner's Exhibit No. 155," is also concerned with the Nikiforoff process, this being an article by Pantjuchow, in 1902. This is of interest particularly, in two respects, that by the first cracking he has obtained 38 per cent from this Russian, of products of useful character—that is, which can be used for the making of benzol, and which, from the other article, is known to be a product boiling below 200 de-

[fol. 276] grees Centrigrade, which would be 392 degrees Fahrenheit, of gasoline character.

He then re-cracks this product into benzol.

This article further states that "The factory is only equipped to work up one hundred thousand to one hundred and fifty thousand pood naphtha." A pood is thirty-six pounds. So this is a plant that was actually operating commercially.

"Petitioner's Exhibit No. 148," Oglobin, in 1905, discloses cracking under two different conditions, one using temperatures of 525 to 550 degrees Centigrade, another at 1200° C., which would be 1022 degrees Fahrenheit, as the equivalent of 550 degrees Centrigrade, and 2,192 degrees Fahrenheit, as the equivalent of 1,200 degrees Centigrade. He discloses further pressure cracking of the low boiling fraction, and gets a yield of benzol of about six per cent. This is a description of the Nikiforoff process.

"Petitioner's Exhibit No. 130," being German patent to de Clercq patent No. 1906, heats in a coil and uses a tube and tank process. The type of condenser, he says, is not important, and he simply does not discuss what type he prefers.

"Petitioner's Exhibit No. 148," British patent of 1908, to Testeline & Renard, uses pressure of five atmospheres and a cracking retort at red heat. He pre-heats his oil to 450 degrees Centigrade, which would be 842 degrees Fahrenheit. He also, it is to be noted, re-works the residues. The condensation is at atmospheric pressure.

"Petitioner's Exhibit Nos. 145 and 146," Noad's British patent of 1908, and United States patent of 1910, cracks in the presence of steam at about 900 degrees Fahrenheit. It is to be particularly noted that he re-works the residual oil. The cracking is carried out in horizontal tube retorts.

"Petitioner's Exhibit No. 131," Kittle French patent, 1910, describes cracking under several conditions. He uses a coil; he uses a tube and tank process; he re-runs the residue and uses a high temperature of 500 degrees Centrigrade, (932 degrees Fahrenheit); he digests in a tank, much as does Ellis; he heats his tubes by means of a metal bath; he condenses at atmospheric pressure, though he uses pressure in his cracking still, including the tank, as well as a coil.

The Master: What is the purpose of that metal bath, in heating?

The Witness: It is only a scheme for giving more even control of the heat applied to the cracking tubes, so that [fol. 277] there will not be high heat applied to one spot, and less heat applied at others.

For example, if we heat with a flame in the ordinary way, the bottom of the tube, against which the hot gasses project will, in general, be heated hotter than the top. With a metal bath that would not be true.

The Master: Then, uniformity and constancy of the temperature is the main purpose of it?

The Witness: Yes. That is the main purpose of the metal bath.

I may add that in Kittle, "Exhibit No. 131," we have, as well, as an alternative proceedure, the bringing of the petroleum into actual contact with the molten metal, by forcing it down a tube which is open at the bottom, and then letting it bubble up through the molten metal.

Mr. Rauber: Is that true of all the Kittle disclosures?

The Witness: No—only the alternative ones. In the primary one the petroleum does not come in actual contact with the molten metal.

"Petitioner's Exhibit No. 115," Allen, in an article in The Analyst, of 1910, compares in detail, the Scottish shale oil product and American well petroleum product, which were "representative commercial products from shale and American and Russian petroleum, "it being noted that the shale petroleum in general gives products more like our present day gasoline, obtained by cracking.

This is one of the few disclosures, in exact numerical terms, of the factors permitting one to measure the unsaturatedness, and so forth, of gasoline and kerosene.

"Petitioner's Exhibit No. 135," being Lang's United States Patent of 1910, cracks under pressure, condenses under pressure, refluxes heavy oils for re-cracking, all under pressure.

"Petitioner's Exhibit No. 132" Turner, United States Patent, 1912, discloses the use of 60 pounds pressure, and temperatures 400 to 800 degrees Fahrenheit, and under other conditions 1,000 to 1400 degrees Fahrenheit. He cracks in the presence of steam, the apparatus being an apparatus for carrying out a vapor phase process. The

apparatus, itself, is primarily a series of highly heated coils.

"Petitioner's Exhibit No. 144," Graef & Walther, British Patent, 1913, gives a good discussion of the commercial [fol. 278] relations and changes which have brought about the desire to crack petroleum to obtain gasoline. He uses pressure of 20 to 50 atmospheres, in leads baths to give them uniform heating, and suggests that the stills may be placed in series. He further suggests a still and tank idea.

The Master: Do you mean a tube and tank?

The Witness: Well, in his case it is two tanks—where the tank holds hot vapor, and this being particularly for what he believes will be the hydrogenization of the olefines. He states that the higher the pressure and temperature, the greater the yield in gasoline. Consequently he is wishing here, to go to high pressure of 20 to 50 atmospheres.

"Petitioner's Exhibit No. 128," is Greenstreet's United States Patent, of 1914. This is a patent which covers essentially a vapor phase process, using oil with steam, largely for the purpose of sweeping out the carbon.

It operates under pressure at temperatures of about cherry red heat, and the product is rich in olefines.

The Master: Now, you have reached the year 1914?

The Witness: I have two more.

The Master: But you have omitted, in that period, as a publication of 1913, the Burton patent?

The Witness: I have not taken any of the patents in suit.

The Master: Up to this time there was no necessity of it, because they did not occur as publications. Now they begin to the ethylene series," and that he does get products of the —ents here brought into question, and historically, they are just as important, as publications, as any other prior publications?

The Witness: Taking the Burton patent of 1913, being one of the patents in suit, we have a patent describing cracking under pressure, with condensation under pressure.

The characteristics of this patent are the use of exact pressures, four to five, and temperatures of 650 to 800 degress Fahrenheit, and the further characterization that the patentee states that he avoids—page 1, line 68—"products belonging to the ethylene series," and that he does get products of the saturated series by his cracking process.

Burton, United States patent, No. 1,105,961, of 1914, being one of the patents in suit, covers the distillation residue of a previous distillation, and the use of the products obtained, as a raw material, for a second pressure cracking distillation.

In other words, it is a case of re-distilling the second time under pressure, of a petroleum.

The Master: And the utilization of steam, or other inert vapors for the second cracking?

The Witness: No. The second cracking is just like that disclosed in the previous patent of Burton.

The Master: In that he does that?

The Witness: No. The first patent, No. 1,049,667, doesn't use any steam or inert vapors or gases.

[fol. 279] The Witness: Humphrey's United States patent, No. 1,119,700, of December 1, 1914, is a process of cracking, which is characterized by pressure, a run-back, and condensation under pressure. It is, of course, in this respect, identical with Pielsticker, with Dewar & Redwood and others.

The Master: To what date do you design carrying out your historical discussion?

The Witness: I was just going to go to one more.

The Master: All right, go ahead.

The Witness: Clark, No. 1,119,496, of December 1, 1914, is characterized by a circulation back and from the tank to the heating coil.

"Petitioners' Exhibit No. 122," Bacon, Brooke and Clarke, 1915, discloses the use of pressures of 60 to 300 pounds, and temperatures from 350 to 500 degrees Centrigrade, which would be 932 degrees Fahrenheit, a vertical retort, a vertical retort heated intermediate the ends, a vertical retort with a receptical below, to receive carbon residues, and the possibility of using these retorts in multiple,—and multiple character being in parallel, rather than in series.

That is as far as I think it is worth while to go on the historical survey.

Q. Do you or do you not find any substantial difference between the shale oil gasolines to which you have referred in your historical discussion of the art and the product described in Ellis Patent No. 1,318,060?

A. They are substantially the same.

Q. How long have these shale oil gasolines been known?

A. For more than 50 years.

Q. Have their properties, the olfine and unsaturated compounds, been known prior to 1911?

A. Yes, well known.

Q. Do you or do you not find any substantial difference between the products described as the result of the pressure distillation of the work of Thorpe & Young and Engler, to which you have referred, and of the product desired in Ellis Patent No. 1,318,060?

A. There is no essential difference between the products described by Thorpe & Young and the Ellis patent you mentioned, or by Engler or his products and the same Ellis patent.

Q. Do you find in the file wrapper of Ellis Patent No. 1,318,060, any reference to the art that you have mentioned in this connection?

A. None at all. There is a reference to a Thorp but it is a different Thorp; it is T-h-o-r-p instead of T-h-o-r-p-e, which is the Scottish Thorpe.

Q. Does this reference to the Thorpe contain any discussion of the olfines or the iodine numbers, a definite description?

A. It does not.

Q. Will you refer to the excerpt in Petitioner's brief?

A. The excerpt reads as follows:

"The fractions collected from the burning oil distillates are more or less yellow, colored by tarry matters which would collect in the lamp wick and soon choke it. To remove these impurities, the oil is put into an agitator, a large lead-lined iron tank, where it is mixed with from 1 to 2 per cent of concentrated sulphuric acid and the mixture stirred by blowing in air at the bottom. The acid unites with the tarry matters and when the blast is stopped, sinks to the bottom and is drawn off as 'sludge acid.' Water is added and after the mixture is agitated, is drawn off. Next, a solution of caustic soda is introduced, about 1 per cent, and the contents of the tank again agitated; then the oil is again washed with water and drawn into the distilling tanks where the suspended water settles out, leaving a bright color oil. * * * If the oil is now found to have too low

[fol. 280] a flash point (P. 295) it is run through 'a sprayer', an upright pipe with crossarms of small perforated pipes through which the oil is forced into the air in thin jets or sprayes. fter flowing some distance it is collected in tanks. By this exposure to the air any light oils such as benzine or naphtha are volatilized and the flash point thus raised."

Q. In the file wrapper of the Ellis Patent No. 1,318,061, of which the Ellis Patent No. 1,318,060 is alleged to be a division, paper No. 19, a letter by the Patent Office, I find this statement:

"It may be said that a mixture of pure gasoline and of benzol would anticipate the third, fourth and fifth claims." Is there anything in the prior art that you have discussed, prior to 1911, that describes substantially a mixture of gasoline and benzol?

A. Bassett in United States patent, No. 65,866 of June 1867, describes such a product.

Q. Just mention it and that will be all right.

A. Also Boynton, United States Patent, No. 58,054 of 1866 in a second one. The intermediate products in the making of Pintsch or Blau gas would be also similar products, as they contain considerable quantities of benzol.

Q. Referring to the last paragraph of "Petitioner's Exhibit No. 100", which I hand you herewith, do you find anything on this subject of unsaturates, and benzol?

Mr. Wiles: Which is "Petitioner's Exhibit No. 100?"

Mr. Rauber: That is Berichte, Volume 30, page 2365 to 2368.

A. The citation you mentioned, states that such a mixture exists when the products of fish oil have been subjected to pressure distillation.

Quoting from the translation:

"Together with the results previously published, it can be said that in the products of pressure distillation of fish oil, the presence of hydrocarbons of the paraffin series (liquid and solid), of the ethylene series and of the benzol series has been proved reliably."

This was in the German publication by Engler and Lehman of 1898.

Q. In the file wrapper of Burton, patent No. 1,049,667, paper No. 3, an amendment filed July 3rd, 1912, in the fourth paragraph under "Remarks", I find the following statement:

"The Dewar patent discloses a process in which pressure [fol. 281] produced in the still, in addition to the pressure produced by the vapor coming off as a distillate."

The Dewar patent referred to as the Dewar patent No. 419,931.

Mr. Dearborn: What file wrapper are you reading from, Mr. Rauber?

Mr. Rauber: Burton No. 1,049,667.

Q. Do you consider this to be an accurate statement of the conditions under which Dewar and Redwood operate their process?

A. I do not.

Q. Dewar and Redwood describe the introduction of inert gases. Would this raise the pressure of the products during distillation; that is, the pressure of the oil being distilled during distillation? Perhaps I had better state that question over.

Do you understand from the reading of Dewar and Redwood patents that inert gas is admitted during distillation?

A. I do not so understand it.

Q. What is your understanding of the purpose and manner of the use of inert gases?

A. The purpose of the gas which is introduced at the beginning of the operation through the opening F', in the run-back, C_2, of the figure of the Dewar and Redwood patent, No. 419,931, is to fill the spaces in the retort not occupied by the oil in the still-head, C_3, and in the condensing coil, D, and column, D_2, with air or gas at the desired pressure. The retort is then heated and the operation begun.

If this was not done, that is, if there was no air or other gas introduced, the first action of the heat would be to distill the oil under atmospheric pressure, or but slightly more at the first and with increasing pressure later, oil which would pass up through the reflux, C^2, and into condenser, D, and we would have passing over, not cracked products, but straight distillate from the oil in the retort.

Q. Do you mean no cracked products at all or just a small quantity of them?

A. Primarily uncracked distillate, though straight distillation is normally accompanied by some cracking, and consequently with some cracked products.

By putting in this gas under pressure we fill the coil, D, the receiver, D_2, the chamber used for refluxing, C_2, and the space above the oil in the retort, C, with gas under pressure. The pressure is shown on the gauge, C^3, and we would pre- [fol. 282] sumably fill it to the point where the safety valve, D5, is where its upset pressure is about reached, say a pressure of four atmospheres. Any vapors given off by the oil into the space, C, of the retort, would push ahead the air, and we would not have increase of pressure beyond the four atmospheres, for anything more than that would be relieved by the valve, D5, and this relief would be at first only of the gas which had been introduced, that is, not of the oil vapors. The oil vapors would gradually push up, pushing the gas out ahead of it, push up into the vessel, C_2, and have the reflux action of that vessel upon them to remove the higher boiling product, and then the low boiling products would pass as vapors on through the pipe into the coil, B, there being condensed and caught as liquid in the vessel, B2.

Q. If you simply set the pressure release valve, D5, for the desired pressure, and attempted to build up the pressure by a volatilizing oil in the retort, C, could you do it?

A. Yes, you would do it and without any particular difficulty. You would, however, have condensing in the coil D prime, and D, some materials which would be of higher boiling point when examined later than would be true through the bulk of the process when normally acting; that is, after the pressure had been built up up to the limiting pressure of the safety valve, D5.

Q. During the time that you are building up this pressure would the condenser, D, counteract the effect of the retort, C?

A. To some extent, but there is always formed, along with the cracking, some permanent gases, hydrogen, methane and other uncondensable gases, and they would accumulate in the system until you reach the limiting pressure of the safety valve, D-5.

Q. What is the purpose of putting in the first gas, then?

A. Only to make the operation simpler from the beginning.

Q. You mean at the beginning?

A. Yes, at the beginning and in the first part of the operation. That is, there is an advantage in that without it there would be a certain time in which the operator would have the cracking and distillation taking place at a lower pressure than this limiting pressure, say, four atmospheres, and in consequence would not know what quality of products would be expected from the receiver, D_2, after they had been condensed. By use of the pressure, put in by means [fol. 283] of the gas, he would have uniformity right from the first products in the condenser, D^2. In other words, the use of the pressure is simply an operating scheme permitting the operator to handle the apparatus easier than if he did not use it.

Q. You mean, easier at the start or during the operation of the device or the still?

A. Easier at the start, later on it would be identical. There would not be any difference because the introduction of air or other gas is only at the start.

Q. On the same page of the file wrapper of Burton Patent No. 1,049,667, I find the following statement:

"The result is that this raises the pressure in the still unduly, and because of this undue pressure the temperature of the liquid being distilled would rise so high in proportion to the pressure as to prevent the distilling off of gasoline of the paraffin series and would result in distilling off gasoline of the olefine series, * * *."

Assuming that inert gases were forced into the still head, C_2, during the distillation, would this raise the temperature at which the liquid is being distilled?

A. Not in the slightest.

The Master: Would the introduction of steam prevent the raising of temperature?

The Witness: Not at the point where Dewar & Redwood put it in. It might lower the temperature if it was put in at another point, in the oil itself, but the point where it is put in, F', it would not change it appreciably. If it had any effect it might lower it a degree or two or three.

The Master: What would be the effect if you put it in at the point where Burton puts it in his patent?

The Witness: Burton does not put it in. Only uses self-made gases in his patent.

The Master: I think he does in one of these patents referred to.

The Witness: I think that is one of the patents that is not infringed.

The Master: Very well.

Q. Could you get self-generated pressure in this Dewar & Redwood still at the start of the operation?

A. On filling the apparatus and starting to heat the retort you would have some petroleum vapors given off and they would give some pressure; the longer the time and the higher the temperature at which heating was applied to the still, you would have the greater amount of gases and [fol. 284] vapors evolved, and, hence the greater the amount of pressure obtained until it reached the point where we reach the upset pressure of the valve, D_2, but above it would not go, because any excess would be relieved and pass away.

The Master: Burton seems to think that the introduction of steam or other inert vapor prevents further cracking, is that true?

The Witness: I think you are referring to this other patent.

The Master: I am, yes. Nevertheless, it is introduced for a purpose.

The Witness: It prevents, though it is quite the contrary to what he has stated in this file wrapper. I think that that will be true if the steam is inserted either in the liquid oil or just above.

Mr. Rauber: Pardon me, if I may offer a suggestion: I think there is some confusion. The patent to which you refer, if I recall, has steam introduced during atmospheric pressure distillation, has it not, and not during the cracking?

The Master: Introduced in this patent of Burton's in the distillation of the residue.

The Witness: I think that was atmospheric.

The Master: Nevertheless, introduced for a purpose, and it discloses Burton's idea of what was the effect of introducing steam or other inert vapor.

Mr. Rauber: Is that a patent for producing lubricating stocks?

The Master: No, a process for producing asphalt.

The Witness: What your Honor is describing is what we have discussed as straight distillation, and the fact that by the use of vacuum, or with steam, in straight distillation, atmospheric, we decrease the amount of cracking and that would always be true, because we have the effect of lowering the temperature needed to distill.

Q. On page 3 of the affidavit of Robert E. Humphreys filed September 30, 1912, as paper No. 4, in the file wrapper of Burton Patent No. 1,049,667, I find this statement:

"And this result is not obtainable by distillation without pressure, but by superheating the vapors considerably above the normal boiling points of the liquid."

Do you understand the Dewar and Redwood process to be one in which distillation is conducted without pressure, but by super-heating the vapors above the normal boiling points of the liquid?

[fol. 285] A. It is not It is a process in which it is conducted with pressure and with a minimum of super-heating of the vapors above the liquid, almost none; almost no super-heating.

Q. Further, on the same page, the affidavit states:

"Affiant says that to make the said tests he took the gasoline product by distillation of the heavy residues referred to, obtained without pressure and with vapors pre-heated to between 800 degrees and 900 degrees Fahrenheit."

Does this correspond in any respect with the disclosures of the Dewar and Redwood patent, No. 419,931?

A. No, in that Dewar and Redwood do not superheat the vapors.

Q. On pages 2 and 3 of the same affidavit, I find this statement:

"Affiant further says that the aforesaid purpose of the said process is accomplished by distilling at a temperature of from 650 degrees to 850 degrees Fahrenheit, the volatile constituents of the residual liquid treated conducting off and condensing said constituents, and maintaining a pres-

sure from about four to about six atmospheres on said liquids and the vapors throughout their course to and while undergoing condensation."

Disregarding the specific temperature and pressure conditions stated, does this process resemble the Dewar and Redwood process?

A. It is the Dewar and Redwood process.

Q. From your reading of the file wrapper of the original specification as filed in Palmer patent, No. 1,187,380, do you understand that this patent to be applicable to aromatic hydrocarbons?

A. The first three lines of the original specification read:

"My invention relates particularly to improvements in making various hydrocarbon compounds of the aromatic series from crude petroleum and petroleum residues * * *"

In other words, as I understand it from here, the original specification is concerned exclusively with the making of aromatic hydrocarbons rather than with gasoline from crude petroleum and petroleum residues.

Q. Referring to "Petitioner's Exhibit No. 102," in the article by Kraemer and Spilker, in the second paragraph and the beginning of the third, do you find any description of the steps of first digesting and then distilling under reduced pressure?

A. I do. The exhibit mentioned states:

[fol. 286] "The apparatus in which the disassociation was produced is the well known distilling boiler provided with a regulating valve and constructed of wrought iron, in which it is possible to do distilling work up to 25 atmospheres with the pressure being kept at rather constant values. In the case of xylenestyerene the disassociation was successful even at as low a pressure as ten atmospheres. Indeed, after some experience, it was possible to carry out the process without the formation of a cokey residue, as soon as it was found that the pressure must be relieved after the gas disassociation has ceased, or as soon as the pressure has decreased, where, after the remainder of the content is continued to be distilled in the presence of strong air diminution—"

Strong air diminution would be vacuum.

"In this manner in a normally proceeding test, with initially ten atmospheres and subsequent vacuum we obtain from 500 grams of materials——"

Q. That is all I want.

A. I do not presume it is necessary to read further. In one case they have distilled, after digestion at the high temperature of 25 atmospheres; the second time at the high pressure of ten atmospheres and later distilled, using vacuum, which would cause——

The Master: This has reference to the Palmer patent?

Mr. Rauber: I was just going to ask him, your Honor, to compare this with what he understands to be the Palmer process.

The Master: From an intelligent reading of Palmer, you can see that is practically what he says.

The Witness: It is substantially the same as the Palmer process.

The Master: Furthermore, on the third page of this patent, it says:

"Throughout the claims the term 'hydro-aromatic' as used, includes the cyclic and hydro-benzenes, including naphthenes and the poly-methylenes" and so forth, which you understand has reference to the aromatics, do you not, as described in the original specification?

The Witness: Not quite. From hydro-aromatics, by further cracking, you can get aromatics, but they are not, themselves, aromatic compounds.

The Master: Then you think that between the time when he filed his original specification in 1907 to the time when it was finally allowed, he makes some essential changes?

[fol. 287] The Witness: I do.

Q. Will you please state briefly about what percentages of gasoline could be obtained from the various types of crude oil by straight run distillation?

A. The values by straight run distillation will vary considerably, depending upon the crude oil used. For example, if we use a Gulf Coast crude, such as that from Vinton, Louisiana, the percentage will be probably in the range of one per cent or less; whereas, if we will take that from the Texas field, the so-called Pioneer Field, we may go up as

high as 34 per cent, and the Mid-Contient Field about the same, say, from 27 per cent. varying with the different localities somewhat within the field. In the Pennsylvania Field we may reach as high as the oil from the Bradford Well, running as high as 38 per cent. On straight run distillation, without any cracking, we would get that much gasoline. So that it depends very largely upon the source of the crude oil, as to what percentages of gasoline will be the yield by straight run distillation without cracking.

Q. About what additional quantities can be obtained by cracking in these instances?

A. I would say that, in general, we can take the portion which is not gasoline or kerosene and obtain, roughly, from it, fifty per cent yield of gasoline. Fifty per cent, perhaps, is the limit, and when that is done, we will have to handle our stills with great care or we will be injuring the still, due to carbon formation simultaneously. Some of the oils are somewhat easier to crack than others and do not give us much trouble from carbon formation.

Q. In the case of oils containing little or no gasoline then, the gasoline must be produced mainly by cracking, is that true?

A. Yes. From such a one as this Vinton oil we would have to obtain it exclusively by cracking, or from Mexican oil exclusively by cracking, and we could obtain, roughly, fifty per cent yield of gasoline.

Q. How do the quantities of these various oils compare; quantities produced, I mean?

A. I am afraid I cannot give you accurate figures on that from memory.

The Pennsylvania oil is decidedly decreasing in amount, the amount being perhaps approximately half what it was twenty years ago.

On the other hand, other oils, such as the California oil, are much larger than they were twenty years ago; the same is true of some of these Texas oils. We may say, in general——

The Master: You mean quantity of production?

The Witness: Yes, the quantity of production.

A. (Continued.) The number of barrels of crude oil produced from Pennsylvania, Illinois, Kentucky, Indiana, is

decreasing; the amount produced from California, Wyoming, Texas have in general increased very decidedly from what they were ten or fifteen years ago.

The Master: There is some place, either in the record or some other place, a prepared table of the production of these various fields, which I have seen. Is it in the record?

Mr. Rauber: I do not recall, your Honor.

The Master: I have seen it some place. Newspapers print those things and one picks them up unconsciously. I have seen a table of that kind showing the comparative production of the various fields throughout the country, but I do not know whether I have seen it in this record or elsewhere.

The Witness: The United States government furnishes such statistics and also the American Petroleum Institute publishes such statistics. In general, I think we could say that the light oils have been decreasing; those which give gasoline on straight distillation have been decreasing; whereas, the oils which are heavy oils and which have to be cracked in order to get gasoline, have been increasing.

[fol. 288] Mr. Rauber: I would like to offer as "Petitioner's Exhibit No. 232," pages 280, 281, 282, 283, 284, 285, 288, 289, 290, 291, of the book "A Practical Treatise on Petroleum," by Benjamin J. Crewe, published in 1887. Dr. McKee made reference to this in his talk.

(Marked "Petitioner's Exhibit No. 232.")

The Witness: I find, in reading this typewritten testimony, two errors that were made, and I think they are my errors and not the stenographer's errors.

On page 410——

The Master: Of the typewritten transcript?

The Witness: Of the typewritten transcript, I mentioned Fig. 3 of Aisinman's "Petitioner's Exhibit No. 118," as being a double walled dephlegamator through which water flowed between the walls. This is incorrect. Oil vapors flow between the walls and air flows, outside and inside the vessel.

On page 627 of the typewritten record, I apparently did not quite finish what I had intended to say, in that I said that the still wax was the residue left in the still on atmospheric distillation after the paraffin product had been dis-

tilled. That is not quite correct. It is the part last left in the still and last distilling over before coke is obtained in the residue of the still, and is, accordingly, last distillate rather than the residue left in the still.

Those are the corrections that I wish to make.

[fol. 289] Cross-examination.

By Mr. Neave:

Q. Dr. McKee, are you familiar with the cracking processes which the defendants are using?

A. I have seen some of the processes in operation, but it has been twenty years—no, it has been nearly thirty years since I visited one of the plants, and I do not think they were then using a cracking process. It has been ten years since I visited another one. I did see one in operation last spring or summer.

Q. Which of the patents——

A. (continued). I think I have probably seen one or two others in between, say, six or eight years ago, but I am not certain regarding that; only casually if I did.

Q. Which of the patented processes used by the defendants have you seen in operation?

A. I have seen a process said at the plant to be a Burton process, but which was not strictly in accordance with the Burton patents which are in suit here.

Q. Is that the only one?

A. No, I have seen another cracking process, or another type of cracking process in the defendants' plants, but that was, as I said, eight or ten years ago, and I do not recall the details regarding it. All of these, I may add, were before my connection with the case.

Q. Where and when did you see the so-called Burton process that you have just referred to?

A. In Providence or near Providence, Rhode Island, at the Standard Oil Company of New York's plant, in, I think, of June this year; possibly the first of July.

Q. Where was it you saw the other processes some years ago?

A. At Bayonne or Bayway, New Jersey.

Q. Do you know what process that was called?

A. No, I do not now know; and the earlier was the Standard Oil Company of Indiana at Whiting, Indiana. I have

seen cracking processes in other plants, but not of the defendants', I may add.

Q. Whose plants?

A. One a Dubbs' process, also another at a plant near—I have forgotten which plant it was—near Chicago or Milwaukee. I think near Chicago.

The Master: Was that the Sinclair Oil & Refinery Company's plant?

The Witness: I am not certain which it was. It might have been Sinclair. I am not referring to the Whiting plant near Chicago, but another plant which was possibly nearer to Chicago than that.

Q. And these processes that you have mentioned are the [fol. 290] only ones you have seen in use, and you have given the places where you have seen them in use?

A. No, they are not the only ones I have seen in use. I have seen the shale oil plants of Scotland; I have seen a plant, which, in its essence, was a cracking process, which I had a relation to. I have seen probably eight or ten other plants using petroleum oils of experimental type, and cracking shale oils, some of them, cracking well petroleum oils, others of them. Oh, I should say all told I have seen ten or twelve plants.

Q. Including the shale oil and the aluminum chloride plants?

A. Yes.

Q. There have been offered in evidence here, and I believe you referred to, 27 patents belonging to the defendants. In your discussion of them have you had in mind the portions of them that are used by the defendants?

A. Yes, to the extent that the attorney for the Petitioner called my attention to the portions which were said to describe the processes admitted in the interrogatories to be used by various defendants, other than the owners of the patent.

Q. Did you agree that they were in those instances used by the defendants?

A. Did I what?

Q. Did you agree that they were used by the defendants?

A. I have no knowledge of that. The interrogatories were the only evidence that was brought to my attention that they were in use by the defendants.

Q. Then you have no such knowledge of the defendants' processes that would enable you to compare these patents that have been put in evidence with the defendants' processes and determine for yourself whether or not those things described in those patents are used by the defendants?

A. I have to the extent of my general knowledge and general acquaintance, as a chemical engineer with the petroleum industry, and general knowledge as to what the defendants are using, and also, as I have said, I have seen the Bayway or Bayonne, I don't remember which one, plant; and the Standard Oil Company of New York plant at Providence and have some general knowledge from those visits, but I have not inspected the plants to find out how each plant operated is carrying out the processes.

Q. Then, from all of the knowledge that you had, do you agree that the defendants are using the things disclosed in these patents?

A. I think in the great majority of cases they are not [fol. 291] using them, and that the statements shown me in the interrogatories are incorrect.

Q. Can you tell me what you mean by the "great majority of cases"? Can you tell me in what respects you do not agree?

A. Well, for example, such a case as the Palmer patent, the digestion feature. The Palmer patent is primarily for a process which is not a continuous process; that is, in which oil is not heated and at the same time vapors coming over and being condensed, and I think so far as my general knowledge goes that the defendants are all using processes in which during the cracking process the condensers are working and the oil being condensed. That is only from my general knowledge and the particular two cases——

The Master: Do not the answers to the interrogatories eliminate all question as to which of these processes are being used and which are not?

The Witness: No, for example, in Interrogatory 20 from the Standard Oil Company of New Jersey's answer to interrogatory, relative to Palmer Patent No. 1,187,380 of June 13, 1916——

The Master: Interrogatory 20?

The Witness: Interrogatory 20, page 226, reads:

"If, for the purpose of the Palmer invention, the continuous cracking with continuous evolution and release of volatile products of the reaction, together with the non-volatile products thereof shall take place in the soaking drum of the defendant's tube and tank process, is the equivalent of the digestion step described as carried out in the Palmer digestion, 20, then the defendant uses the process of all of these Palmer claims in the tube and tank cracking operations."

The Palmer invention is not one in which there is continuous cracking, continuous evolution and release of volatile products of the reaction.

Q. Is that the only criticism you have to make?

A. No, that is not the only one. I have many others but that is, perhaps, the most pertinent and illustrative of what you asked me. You asked me if I knew of any of these cases and that is illustrative.

Q. It is hardly illustrative of a majority. You used the words "the majority of them were not being used—". Now, which are the patents that you say are not being used by the defendants from your general knowledge?

A. The ones offhand that, perhaps, are most obvious are the Adams with the electrical heater; the Adams with the hot plate heater.

[fol. 292] Q. There is nothing in the interrogatories stating that the defendants are using that, is there, the electrical heater?

A. I think there is or it would not be in here. This Adams with the electrical heater patent would not be in if that patent was not stated in interrogatories as being used. I think I can find the place where it states that that patent is being used.

The Master: I do not recall that the Petitioner has yet offered evidence to controvert the answers to these interrogatories.

Mr. Neave: I was trying to find out, your Honor, what the position of the Petitioner was, as to whether this witness, in his testimony, was attempting to controvert those allegations in the interrogatories.

The Master: In the answers to the interrogatories?

Mr. Neave: Or rather in the answers to the interrogatories. I am trying to get what his testimony has amounted to.

The Master: Oh, yes.

Mr. Fowler: I suggest he is not representing the Petitioner as an attorney; he is simply a witness.

The Master: I do not understand that the Petitioner has gone into the question at all, or taken up the question of the answers to these interrogatories upon a contention that any of them were not true.

Mr. Rauber: Your Honor, I think that the defendants have not yet proved that they used any of these things. We do not have to prove that they are not using them or are not infringing these patents until they prove they are.

The Master: The purpose of the interrogatories is to limit the issue. You have asked certain interrogatories; they have been answered, they will stand as a fact; the answers will stand as facts, unless the Petitioner introduces some evidence to show that the answers are not true. Of course, some of them are answered hypothetically or subjectively, "that they are good ones," and all that sort of thing. Well, I do not know what is going to be the effect of that. I suppose in the argument it might cast on the poor Master the duty of finding out whether they are equivalents or not.

Do not let me limit the scope of your cross examination; I just thought we might save time here.

Mr. Neave: I would like to save all the time I can, but I was trying to find out what the purport of the testimony given by this witness is. If he is controverting, or attempt-[fol. 293] ing to controvert, those answers to the interrogatories, I would like to know it.

The Master: It has not been developed.

The Witness: Reading from page 227 of the Standard Oil Company of New Jersey's answers to interrogatories, Interrogatory No. 26. Adams patent No. 1,320,354, of October 28th, 1919, subdivisions 13, 14 and 23:

"If, for the purposes of the Adams' invention, the heating coil in defendant's tube and tank process, which coil is approximately four inches in diameter by 2,500 feet in length and discharges into vertical, insulated and unheated soaking drums, six foot in diameter by thirty and forty

feet high, is the equivalent of the heating section, A, and dome, E, of the Adams' patent, and if external fire of this coil is the equivalent of the heating by heater, 107, of Adams, then the defendant uses an apparatus described by these claims."

In my mind there is not anywhere near the similarity between this electrical heating and the external heating of a 4-inch coil, a similarity sufficient to permit it to be considered as the same thing.

Q. And it is only with reference to that kind of an interrogatory and to that kind of an answer that you question the correctness of them; those answers that begin with some "if" or some hypothesis?

A. I have only read, perhaps, one-tenth of the interrogatories.

Q. Oh.

A. (continued). But the Adams' Patent, No. 120,726, would be another one which would be just as slight in its relation to the process which is customarily used.

Q. Now, referring again to these 27 patents of defendants that have been put in evidence, of which you have spoken, it is your position that all of these 27 patents disclose and claim processes which represent no advance in the art; is that what you have been testifying to?

A. No.

Q. What is your position, then, with reference to those patents?

A. My position is that the fundamentals of these processes have been disclosed, and that there are only minor improvements in cracking, which have been disclosed in these 27 patents.

Q. And what are those minor improvements—please enumerate all of them.

A. For laboratory use in cracking, the use of the electrical heater. It is not of interest from the question of [fol. 294] commercial use.

The same might even be said of Adams' plate scheme. They are of convenience in the case of Clark's scheme of pipe arrangement, in his United States Patent No. 1,124,797, of March 28, 1922, this making a more convenient scheme than Dewar & Redwood's, possibly.

Do you want me to go through the whole 27?

Q. All the improvements that you say they contain—all the things that you say they contain, which you say are improvements.

A. I will go through them in order, then.

Burton's Patent, No. 1,049,667, of January 7, 1913—possibly the temperature gauge, 5 and 6 in the figure. That is not claimed in the patent, but that, I think, probably represents the entire contribution, in that Burton patent.

Burton, No. 1,1015,961, I don't believe carries anything new.

The same is true of Humphreys', No. 1,119,700. I think it is also only a paper patent.

Q. What do you mean by that?

A. That it is only worth the paper upon which it is printed.

Clark, No. 1,119,496, December 1, 1914—I am not certain that there is anything here that is new. Possibly the rapid circulation—the rapidity of circulation of oil through Coil 4, is new, although I am not certain that it is.

Clark, United States Patent No. 1,129,034, February 16, 1915,—the use of a minimum amount of gas in handling the pressure of sills, by means of this complex type of pipe layout, as shown in Fig. 1.

Q. Do you say that is new?

A. I don't know of anybody else that furnishes a scheme which can get along with as little gas as Clark's can.

Burton, No. 1,160,689—I think carries nothing that is new.

Burton, No. 1,167,884—January 11, 1916,—the expression in a mathematical form, of what was common knowledge before, in the way of a complex algebraic equasion.

Hall, No. 1,175,909—I am not certain whether anyone has previously described the use of catalytic agents, and pressure simultaneously. Pressure has been used by itself, and catalytic agents have been used by themselves, but I think they have not been described in simultaneous use, so I am not certain. The claim is made—page 2, beginning with line 47—by inference, that the product is a different type of product from that made by other processes. This I question whether the patentee was correct in stating.

[fol. 295] Palmer, patent, No. 1,187,280—I don't believe that Palmer made any contribution to the art, though he

has made some statements, which, if true, would be contributions to the art.

For example, page 2, line 13.

"There was, apparently, a sudden conversion of the materials present, into more volatile compounds, which caused a rapid increase in pressure, as shown, without the indication of any great increase in temperature."

"Since the heat was being uniformly applied thereto, it is apparent that at this pressure there was a large absorption of heat, which prevented any noticeable indication of an increase in temperature. Such absorption of heat being, evidently, due to the formation of new compounds, which, as the results show, are to a certain extent, cyclic in character."

Possibly his contribution is best shown in Fig. 1, page 1, line 96:

"The jacket, 15, preferably as shown, being provided with some coils, 16, completely surrounds the said digestor."

If there was any contribution, it was such minor contributions as these.

Hall Patent, No. 1,242,795, of October 9, 1917—in the Hall patent, just mentioned, the new element is the compressing after the use of the preliminary cooling—that is, the run-back. There is also a new element which, if true, would be of importance. I am reading, now, from page 1, line 6:

The chemical fixation of a hydrocarbon gas to vaporize normal liquid, chemically unsaturated hydrocarbons, the said gas, or liquid, having the properties that you have specified."

Hall Patent, No. 1,242,796, of October 9, 1917—that is, it may be noted that it was issued the same day as the previous one—carries essentially the same idea of compression before going to the condenser.

Ellis Patent, No. 1,318,060, of October 7, 1919—this is an absolutely useless patent, covering a product which has been known for several decades.

Patent No. 1,318,061, discusses the use of sulphuric acid, of 80 per cent, or less, as a refining material, and that is the basis of the patent. But even that was old.

Adams, United States Patent No. 1,320,354, of October 28, 1919, is the patent which I mentioned earlier, where the heating unit is a series of graphite rods, heated to incandescence. It is an internal heater, free from the walls of the retort. That is the new principle in this patent.

Adams Patent No. 1,320,726, November 4, 1919—the use of a perfectly flat plate is, I think, new. Also, a perfectly [fol. 296] flat plate, with molten metal above it, is new. Particularly the use of these two, under pressures. There are descriptions in which a curved plate is used under pressure, but not a flat plate alone, on a flat plate carrying a thin layer of molten metal.

Adams, No. 1,320,727, November 4, 1919, describes the apparatus in connection with the process patent which I have just mentioned.

As between these two, the new element that I have mentioned is in the apparatus, rather than in the process.

Adams, No. 1,327,263, of January 6, 1920—I think, perhaps, in this, the most striking thing is that the first six pages are essentially for a vapor phase process; whereas, pages 7, 8, 9 and 10, are essentially for a liquid phase process. It is, I think, rather new, to describe in the specification one kind, and in the claims to describe another type of process. The disclosure on page 4, lines 9 and down:

"The oil containing and cracking chamber 12, may be constructed of various heat enduring metals, alloys, carbons, graphies, graphitic carbons, and other materials known to stand a constant, or varying tempera-ure of high in-ensity."

This list contains unexpected materials to be used as materials for the cracking retort, to be used under pressure. However, it must be borne in mind that, as was brought out in my direct testimony, the pressure is only to be used on oils which are less dense than 50 degrees Baume, and that vacuum is supposed to be used on oils of the type which are ordinarily cracked, such as those with a density of 50 degrees Baume.

Perhaps the most characteristic point in this patent, is the intense temperature used, but that is not new to the art. There were cases before.

Lewis & Cook, Patent No. 1,392,584, October 4, 1921—probably the newest thing in this would be the idea that the bubble tower could operate without some scheme of cooling, on a commercial plant sized apparatus, as is apparently sketched, without some scheme of cooling by other than air. There would be no chance of it operating well. In needs some sort of a dephlegamator. And by operating, mean operating successfully for the purpose for which the patent claims it.

Clark, No. 1,410,797, March 28, 1922—I should say that here the system of pipes for feeding and connecting and emptying a plurality of cracking stills—that this system, which is shown, is probably a good system, and may carry something that is new. It is, however, of not great importance.

Ellis, No. 1,415,232, of May 9, 1922—this is a vapor [fol. 297] phase process, with a minor amount of liquid contained there, but I know of nothing that is really new, disclosed in this patent.

Cross, No. 1,423,500, of June 18, 1922—probably the most definite thing that is new in this, is the idea that a cracking of an oil takes place at a definite temperature of approximately 750 degrees Fahrenheit.

The Master: In all instances?

The Witness: Apparently this man thinks that it takes place there all the time, which we know to be quite incorrect. In other words, that this conversion temperature is a definite temperature.

Furthermore, I think it is brought out from the file wrapper, that the patentee considers that less olefines are formed in such a process, than in other types of cracking processes. This is, possibly, true, but not likely. I do not recall any other tube and tank process which has connected with it a heat interchanger, where the vapors from the reacting chamber are used to pre-heat the oil to be fed to the tubes.

Adams' patent, No. 1,443,519 of October 24th, 1922, has as its new idea the use of electrical heating with internal heaters, free from the wall of the retort and used in series. The use in series of the retorts so heated is the particular

thing that this patent discloses; furthermore, the disclosures of constant level devises in connection with electrical heating apparatus is new.

Burton and Clark. United States patent, No. 1,448,254 of March 13th, 1923, is a process patent, but the new point is from the Fig. 2, the use of inclined tubes, so that the entire apparatus looks like a water-tube boiler, with a somewhat diminished lower drum and a somewhat enlarged upper drum. The process, as itself, is nothing but what we have found in the prior art.

Adams patent, No. 1,461,017, of July 3rd, 1923, is an apparatus patent corresponding rather closely with the process patent, No. 1,327,263 of January 6th, 1923, of Adams.

I am not certain but what it is new to use a helical scheme for the removal of carbon from a retort. There have been other schemes in which straight scrapers were used, but the use of the helical scheme may be new.

The suggestion of graphite, carbons, and graphitic carbon, as a material for retorts for cracking of oil is new, I am quite positive.

Manley patent, No. 1,462,143 of June 17th, 1923, has the feature of the injection of the return condensate by means of the flow of new oil through pipe, 10, into the retort at the point 4A, is, I think, new. He puts a great deal of em- [fol. 298] phasis on the scheme for the removal of carbon by means of steel brushes, but that is far from new; Intschick describing the exact scheme.

Adams patent, No. 1,462,677, of July 24th, 1923: This is a vapor phase process in which there is the use of a helical scraper for removing carbon from the walls of the retort. In this patent, for example, page 2, line 120 and elsewhere, there is an obvious lack of recognition of the amount of latent heat required for vaporization.

The Master: This is the process for the use of the apparatus patent, No. 1,461,017?

The Witness: No. The apparatus is in patent No. 1,462,678, which is the next patent.

Although there are twelve pages of this patent besides five pages of drawings, I find nothing of importance which I believe to be new to the art. The use of the helical scraper in the helical form I have mentioned as coming out in one of his earlier patents.

In the corresponding apparatus patent, Adams United States patent, No. 1,462,678, should belong the mention that I made a moment ago of a helical scraper, as that is part of apparatus rather than of process.

I think possibly there is one newer idea, and that is, that when cracking is carried out rapidly, instead of slowly, that the quality is of higher quality, for example, in the apparatus patent, page 5, lines 105 to 110.

I do not recall, in the case of vapor phase cracking apparatus, such as this of Adams, the use anywhere of a double tube, fed by a single spray as is indicated in Figures 6 and 7 and elsewhere in this patent.

A. I believe that finishes the 27.

Q. Do you want to mention the Chamberlain patent? I think you did mention that in your direct.

A. I overlooked that. It was not in my book.

I think, on page 8, lines 43 to 59, we have one of the two phases which are the essence of this patent:

"In reciting in claims following that the oil is free from still wax and like heavy matters of sticky character, and from elements yielding the same, or coke, a practical rather than a theoretical perfect freedom is to be understood. It suffices, for example, if the oil operated upon be distillable in an externally heated still of the dimensions hereinbefore mentioned for still, A, charged 6/10ths full under a super-atmospheric pressure to seventy-five pounds to the square inch at the aforesaid rate of two per cent per hour to the extent of twenty per cent or more by volume of [fol. 299] its component hydrocarbons which have viscosities above 70 second 100 degrees Fahrenheit without heating the still bottom to redness."

When it is borne in mind that, for example, the Burton process carried out at Providence distills considerably more than this from a raw oil and from most any raw oil, this requirement which, on its face, looks like that it is a limitation, means nothing; and, again, we have discussions of the use as if it was a particular raw material—as if it was a special oil or oils which carry, say, 10 per cent or more, having a viscosity of 70 seconds to 170 seconds at 100 degrees Fahrenheit, using an Engler Viscosimeter, and using between 90 and 10 per cent of a heavier oil. We have

simply a definition, essentially, of crude oil. If I would say that there was anything characteristic of this Chamberlain patent, it was the ability to define crude oil and distillate oil in unexpected ways, and ways which would look as if it was a special oil. And similarly, to define the residue left after skimming or topping process.

There is one statement here that is interesting. I refer to page 7, line 30:

"I have obtained larger yields, however, both of naphtha and of burning oil (kerosene) from distilling mixtures of (1) hydrocarbons with viscosities normal to heavy lubricating oils, and (2) hydrocarbons with the intermediate viscosity mentioned, than from distilling like volumes of said two kinds of liquid hydrocarbons separately, and I believe that the same principle would hold true with respect to hydrocarbons with viscosities normal to medium lubricating oils. It is also my belief that better oils are attainable by distilling oil in which two or more of said three kinds of liquid hydrocarbons are naturally present, than by separating said hydrocarbons, and then permit a mixture artificially of them in their original proportions."

This simply means that he advises distilling either a crude oil or a residue oil rather than to purify the oil and then to separate, and separately crack them; if this is true it is interesting.

I do not know whether it is true or not but it is, so far as I know, a new statement in the cracking part.

That, I believe, completes the 28.

Q. You know, do you not, that substantially none of the things you have said were new in these various 27 patents?

A. 28.

Q. 28 patents that enter into the claims of those patents.

[fol. 300] Mr. Rauber: How do you mean that, that they are not described in the patents or not claimed?

Mr. Neave: Not claimed. He has spoken of some of the patents having claims so and so; he definitely read the claims.

The Master: The claims which Dr. McKee mentions are not the things which the inventor claims were new and useful?

A. In the Chamberlain patent, for example, which is the last patent I have taken, we have in Claim 1, reading:

"The process of obtaining hydrocarbon products by decomposition of hydrocarbons, which process consists in operating upon an oil—"

and I want to stop there and call your attention that if spitting on an oil would decompose the hydrocarbons, this patent would cover spitting on an oil.

And then, from there on, the next portion is a definition of ordinary petroleum oil:

"That contains hydrocarbons with viscosities intermediate, 70 seconds and 100 seconds at 100 degrees Fahrenheit, and also liquid hydrocarbons with higher viscosities in the relative proportions of not less than 10 per cent by volume of hydrocarbons of either kind, but not exceeding 90 per cent of hydrocarbons of the other kind; and that it is free from still wax and like heavy matters of sticky character, and from elements yielding the same, or coke, by distilling such oil at decomposing temperatures under a super-atmospheric pressure at not less than 30 pounds per square inch, substantially as described."

It is to be noted that the point I have mentioned is a part of the claim, it is a part of that which I gave and is a part of the claim. The same is true of practically every claim here in which this comes in.

Similarly, in Adams Patent No. 1,320,354, we have the mention of electrical heater, in Claims 1, 2, 3, 4, 5, 6, 7, 10, 21, 25, 26, 28; a total of 12 claims in a single patent.

In Adams' patent, No. 1,320,727, we have a mention there of the flat portion in the flat plate, or referring to some other phase of the flat phase of it—a flat piece of apparatus; claim 9, the constant oil level, that I mentioned, I believe, in connection with this patent. Claim 12, Claim 13, Claim 14, the flat bottom plate, Claim 15, the flat bottom plate, Claim 16, the flat bottom plate; Claim 17, the flat bottom plate; Claim 18, the flat bottom plate; Claim 19, the flat bottom plate; Claim 22, for the constant level device, Claim 23, for the constant level device; Claim 24, for the constant level device; Claim 25, for the constant level device; Claim [fol. 301] 26, for the constant level device; Claim 27, for

the flat plate; Claim 28, for the flat plate; a total of 16 claims which cover the special things which I have mentioned.

Do you want me to go through the entire list?

Q. I want a complete answer to the question.

A. How is that?

Q. I want a complete answer to the question.

A. I will ask, then, because I am not certain what I gave for all of the patents—

In case of Burton, No. 1,049,667, I believe there is nothing claimed there which I mentioned as new, or there is nothing of importance that is new.

Burton, No. 1,105,961—

Q. You said there was nothing new there, so you need not bother with that.

The Witness: May I ask the Reporter to go back and give me what I gave as the new things when going through that list of 28 patents?

Mr. Neave: Never mind, I can give it to you, Doctor.

Q. In the Clark patent, No. 1,111——

The Witness: No, I want the Burton patent, No. 1,105,961.

Q. You said there was nothing new.

A. All right.

Q. You said there was nothing new in Humphrey and Clark's patent, No. 1,119,496. You said you were not certain but possibly the rapid circulation is new.

A. We have in the Claims, 1, 2 and 3; that is, all of the claims of the Clark patent carries that idea.

Q. In Clark, No. 1,129,034 you said the use of a minimum amount of gas to control the still pressure was new; is that in the claim?

A. A minimum amount of gas to control the still pressure would be a process, and the claims are all apparatus claims, consequently, it cannot be in it.

He discusses on page 1 in the specifications the question of the small quantities of uncondensed vapor gas and its utilization, but the apparatus claim could not carry a process step.

Q. In the Palmer patent, No. 1,187,380, you said that possibly the tank, 15, and the steam coils were new.

A. Here we have the reverse of what we had in the Clark patent, inasmuch as this is a process patent, and the part that we have just discussed is a new thing from the apparatus side, so that the claims could not carry that new disclosure.

Q. In the Lewis and Cooke patent, No. 1,392,584, you said the new idea is that the bubble tower could work with nothing but air cooling; is that claimed?

[fol. 302] A. He defines his bubble tower, not with the words "bubble tower" at all, but "a succession of liquid bodies of petroleum oil through which the vapors pass," and it is mentioned in each one of these. The lack of proper heat control is not mentioned, naturally; in fact, his claims would read for a well-made bubble tower.

Q. You mean by "lack of proper heat control," a lack of proper cooling?

A. Yes, a lack of proper cooling would mean a lack of proper heat control.

Q. You do not know that hundreds of these Lewis and Cooke things have been used with nothing but the air cooling?

A. They were probably not of this design.

Q. You do not know?

A. I do not know.

Q. You said that the Clark patent, No. 1,410,797 discloses a system of pipes and valves which may be new; that is not claimed, is it?

A. Yes.

Q. That is claimed, is it?

A. Yes.

Q. All right.

A. In the fourth claim, in the process claimed by implication because the process could not be carried out without such or somewhat similar sets of pipes, in claims, 2, 3 and 4; 2 and 3 have it as a process, 4 has it definitely as an apparatus.

Q. In the Burton and Clark patent, No. 1,448,254, you have said there was there shown something that looked like a water-tube boiler, a smaller lower drum, and a larger upper drum; that was not claimed to be the invention there, was it?

A. No, it was not. All of the claims here are for processes well known in the art.

Q. Are you familiar with what is known as the Perkin medal?

The Witness: Mr. Neave, you said you wanted a complete answer. You haven't touched at all the Adams patents. I only touched two of them.

Mr. Neave: I thought you named all of them.

The Witness: I only named two of the Adams patents; you were going to give me the data of what I said regarding the others.

Mr. Neave: Will you look through your answers afterwards and see if you want to add anything?

The Witness: I think we would find within several of those, for example, the Adams patent, the factors which I have discussed here as the new factors are the ones which are particularly included in the claims, as I did call attention——

Q. In some of the claims?

A. In some—in the majority of the claims.

The Master: His last question was: "Are you acquainted with a medal that is known as the Perkin's medal"?

[fol. 303] A. I am.

Q. Did you know that that medal was awarded—if that is the proper name for it—to Dr. Burton?

A. It was.

Q. How was that medal awarded—by whom, or by what process?

A. It is awarded, now, differently from what it was when it was awarded to him.

Q. How was it awarded then?

A. A committee, consisting largely of ex-officio members of the Society of Chemical Industry, and other chemical societies, have, first, a nomination ballot, which, normally, comes by mail, and is ordinarily a nomination through the Society itself—through the Executive Council of each Society—instructing these particular delegates to vote for a certain man, and after these nominations have been received, certain men are appointed to write up what might be called a biographical sketch of the nominees.

The Committee, in part then met—I say in part, because the Committee, while a quite large one, was widely distrib-

uted, geographically, there being no provision for substitute delegates for this meeting.

This Committee met and voted, in a preliminary way, for the nominees, after something in the way of nominating speeches, and so on, had been made, and then, ordinarily, the next motion was to move that all having votes less than so many, be eliminated, and that the Committee would then vote upon the remaining ones. This elimination, ordinarily, reduced the number to two or three in number. Then they vote a second time, and if that gave a majority vote for one man, he would be declared the nominee, and, ordinarily, there would be a motion made by one of those who voted for the less popular man, that the vote be made unanimous, and that was formally done.

Then he was notified by the Secretary of the Society of Chemical Industry, American Section, and he was asked to speak, and at a meeting in January, normally, he would be presented with the medal, and would give a speech discussing the various phases of his work.

Q. To receive the Perkin medal is to receive one of the highest honors that can be given in the chemical industry, is it not.

A. It is.

Q. When was the Perkin medal awarded to Dr. Burton—about?

A. I think I have a record here that would give us the exact date, in a moment.

The Master: I don't think that amounts to anything, whether it was one date or another.

The Witness: About 1921—something like that.

Q. And for what is this medal awarded?

A. For achievement in the field of applied chemistry, either for new things, or for putting into commercial use of old things.

Q. And were you a member of the Committee in connection with the awarding of the medal to Dr. Burton?

A. I was not.

Q. Were you a member of any of those subcommittees who wrote up the biographical sketches, and so forth?

A. Not on Burton—not the Burton year. I was before, and I was later.

Q. It is a fact, is it not, that gasoline has long been produced in this country from natural gas, and it is now being obtained from natural gas, is it not?

A. It is now being obtained from natural gas, but it has not long been produced by natural gas. The production [fol. 304] from natural gas is a relatively late phase of the gasoline industry.

Q. How late? It has been going on for how many years?

A. I don't know exactly when it began, but I should say that ten years ago there was not 10 per cent as much made as there is now.

Q. It is true, is it not, that gasoline has long been separated from petroleum by what has been called straight distillation processes, as distinguished from cracking processes, and that gasoline is so being separated from petroleum today, in the United States?

A. It is so.

Q. Then gasoline is also produced by cracking processes, is it not.

A. It is.

Q. How much of the gasoline that has been produced in the United States in recent years, has been produced by cracking processes—that is, what percentage of the total?

A. Two years ago I think it was 26 per cent. I think that the amount is increasing, and is more, now, but I am not quite certain of the exact percentage.

Q. It is true, is it not, that hydrocarbons long have been, and are being cracked by chemical decomposition, such as by the use of aluminum chloride?

A. I think it has not been done long. I don't think that there is any considerable amount being made at present. In fact, I question whether there is a commercial plant operating at present, on aluminum chloride. I know that the Gulf Refining Company has done work, but I think that the McAfee process is shut down—although I am not certain about that.

Q. And that was the production of gasoline, was it not, by means of aluminum chloride?

A. So I understand.

Q. There is a large amount of literature on that subject, is there not, and many patents have been built up, relating to it?

A. I don't know, on that. I should say that there is a considerable amount of literature, though I don't know that I should say a large amount.

Q. In addition to the aluminum chloride process of cracking, there are also electrolytic cracking processes, are there not?

A. I know of none which are electrolytic.

Q. Do you know of any cracking processes depending upon electric discharges, as distinguished from electrolytic?

A. Yes, sir, but I don't know that there are any in opera- [fol. 305] tion. They are only processes which have been studied from the scientific side.

Q. There are many patents that have been devoted to that process, are there not?

A. I think not many. About three years ago I went into that question, and, as I recall, I found only a few.

Q. But such processes have been known for more than three years?

A. Yes.

Q. And much before that?

A. Perhaps another three years.

Q. In addition to the aluminum chloride process, and the electrical discharge processes of cracking, there are also those involving the decomposition of the hydrocarbons by means of heat, are there not?

A. That is the ordinary form of cracking.

Q. And those are of two classes, namely, those carried on substantially at atmospheric pressure, and those carried on at substantially higher pressures, are they not?

A. I don't believe that I know of any, at present, that are being carried on at atmospheric pressure. There were, but not now.

Q. They were in successful use, were they not?

A. They were, in the past, but not at present. I understood your question to read that they are.

Q. Yes, both,—that is, they used to be used very largely?

A. Yes—no, not very largely, because gasoline was not wished particularly. It was rather a by-product. They were carried on, primarily, in the making of kerosene, rather than gasoline, and the coming in of the use of pressure came before the demand for gasoline, so that when the demand for gasoline came it was met, not by the at-

mospheric pressure, but by the super-atmospheric pressure processes.

Q. As I understand it, you consider that at the present time atmospheric cracking processes of oils, are not used for producing gasoline?

A. No, they are not used to amount to anything, compared with the other. The production from pressure cracking is much greater than the production from atmospheric cracking.

Q. Are atmospheric cracking processes now used for producing kerosene?

A. I don't think so, though it is possible that they may be.

Q. And the processes involved in the present case, are not those of producing gasoline from natural gas, nor those using straight distillation processes, nor those using alumi- [fol. 306] num chloride, nor those using electrical discharges, nor those involving the use of heating at atmospheric pressure, but only those cracking processes involving the use of heat at very high pressures—is that not true?

A. No, it is not true.

Q. What is the basis of your, "no"?

A. Because they are not using very high pressures.

Q. What do you mean by very high pressures?

A. 500—300 or more pounds.

Q. That is, they are using 300, or more pounds?

A. No. I say that the processes using very high pressures would be processes using 300, 500 or a thousand pounds. They are not. The processes are using much more—very moderate pressures.

Q. How high?

A. Oh, around the range of 70 or 85 pounds. Those are very moderate pressures at the present date. There are some processes using higher pressures, but the normal process is one using very moderate pressures, such as——

The Master: By normal, you mean the most used processes?

The Witness: Yes. Perhaps the making of the cracked gasoline—certainly more than two-thirds of it is by processes using a hundred pounds, or less.

Q. Do you mean, by that, a hundred pounds above atmospheric, or——

A. A hundred pounds gauge pressure.

Q. A hundred pounds above atmospheric?

A. Yes.

Q. The processes using heat at those pressures that you have mentioned——

A. Which pressures?

Q. The last pressures, which are a great deal higher than atmospheric—would they be, in general, divided into four several classes, namely:

A. Flash cracking processes, where hydrocarbon oils are vaporized and cracked almost instantaneously, in contact with very hot surfaces.

B. Tube cracking processes, where hydrocarbons liquids and vapors are passed through elongated passageways at high temperatures, the time element being relatively short.

C. Tube and tank processes for cracking, where the time element is greatly increased and the temperature generally somewhat decreased, by placing a relatively large unheated, or slightly heated tank at the outlet of the preliminary cracking oil; and

[fol. 307] D. Pressure distillation processes, where the temperatures are comparatively low, and the time element rather long.

The question is whether the processes using heat may be conveniently divided into these classes, as a good working classification?

A. I would say not, because, at pressures of 300 and 500 pounds, or a thousand pounds, we can not use the——

Q. Excuse me, Doctor, I think my question was not, perhaps, quite clear, in that respect. I was not talking, in this question, about those pressures of 300 and 500 pounds, but those lower pressures, which you spoke of, which you said, I think, were 70 to 85 pounds, which I said were high, and that they were well above atmospheric. My question relates to those processes using 70 to 100 pounds.

A. Limiting the question to those processes of 70 to 100 pounds pressure, I would say that such a division is a possible one, but it has some awkwardness in it, as the first of the scheme is dependent upon a process, and the last three upon an apparatus.

Moreover, there are a number of processes which should be defined as processes, rather than by apparatus, as the last three divisions.

And, further, there are processes which partake of the nature of more than one of these.

It is a possible division, but I don't think it a particularly desirable one.

Q. Much of the prior art, which you have cited, belongs in the first two classes, as I have named them, does it not, namely, in either the flash cracking processes, or the tube cracking processes?

A. No, I would say that the largest of the single classes was in the fourth class, perhaps, in which we have tanks, and in which we have distillation taking place simultaneously with cracking—for example, in the Dewar & Redwood—and I think we have, probably as many in that class as in the other three classes together.

Q. But still much of the prior art which you have referred to, does fall within the first two classes—that is, in the flash cracking processes, or in the tube cracking processes.

A. There has been some, but I would not call it much. I would say it was probably one-fifth.

Q. And the processes of the defendants' patents fall nearly entirely in the third and fourth classes, do they not—that is, the tube and tank, or the pressure distillation processes?

[fol. 308] A. No. Ellis patent, for example,—his process patent—No. 1,318,061—which—no, that isn't the right number. It is Patent No. 1,415,232, that I refer to—taking the form of tube and tank process—is actually a vapor phase process, belonging to the first class.

I wouldn't know whether to speak of the Hall process, where you are using catalytics, as belonging to this. It is carried out in tubes, but without a tank. But it is not concerned with that phase of the operation.

The same holds good for the Palmer patent, and for the Hall patent, No. 1,242,795, and for the Hall Patent No. 1,242,796.

There we have vapor phase cracking, and, of course, the Ellis patent, No. 1,318,460, for a product, rather than for a process; and Ellis, No. 1,318,061, for a process of refining rather than for a process of making gasoline.

It is pretty hard to say where Adams, No. 1,320,354, of October 28th, 1919—where he uses electrical heating,

heated to incandescence, belongs—that, apparently, belongs in the vapor phase, though the apparatus is sketched as if it was a liquid phase process. And if it belongs to the vapor phase, it belongs to the first class.

Adams' scheme, using a hot plate, I don't believe would belong, scarcely, to any of these. An apparatus using a hot plate, scarcely would be of the type for any of these in this division. It might be that they belong to your last class, of a pressure distillation, but it is not a long time, at a low pressure, but it is a short time, and quite high pressure.

The Arams patent, No. 1,327,263, is a tube process.

The Lewis & Cooke process is not concerned with the cracking.

Clark, No. 1,410,797, is a process not concerned with the divisions that you have mentioned.

The Cross patent, No. 1,423,500, belongs to your third class—tube and tank.

The Adams, No. 1,433,519, is concerned with the electrical heating, and though, nominally a liquid phase, actually uses temperature of incandescence, and, consequently, it really must belong to your first class.

The Burton and Clark, No. 1,448,254, 1923, belongs, probably, to your third class.

[fol. 309] The Adams, No. 1,461,017, of July 3, 1923, belongs to your second class.

Manley, No. 1,462,143, of July 17, 1923, belongs to your second class.

Adams, No. 1,462,677, would belong to your second class, probably—no, it would belong to your first class, and, possibly, also to your second class. The same thing would be true of Adams, No. 1,462,678.

In other words, probably two-thirds of them do not belong to the third and fourth classes.

Q. You have said that you had a general knowledge of the processes which the defendants were using—all of those processes belong in the third and fourth classes, don't they?

A. I had a general knowledge of what was being used in the art. I have no knowledge as to what the defendants are using, only in connection with two—if you recall—only two plants, one of which was of late—that is, last June—and the other was eight or ten years ago. So that

I cannot know, definitely, what they are using at the present day. In other words, my general knowledge of what the defendants are using, comes down to a single plant.

If you recall my answers to your early questions.

Q. I thought you had a general knowledge, outside of what you had seen, actually. I thought that was what you meant.

A. Of what people are using in the art, but not particularly what the defendants are using.

The Master: What any particular defendant is using?

The Witness: Yes, sir, what any particular defendant is using.

Q. Was it well known, prior to 1916, that when an aromatic hydrocarbon was heated with aluminum chloride, it always tended to remove one, or more side chains?

A. No. If you take the Friedel-Crafts re-action, which is an aromatic hydrocarbon heated with aluminum chloride, and, for example, take toluene, which has one side chain in it, it is benzol, with one methyl group, and heat it with aluminum chloride, you will get some benzol, which is an aromatic, and you will get some xylol, which is an addition—that is, you get both the removal and putting on of side chains, which tends to an equilibrium.

Q. But you do get some removal?

A. You get some removal, yes.

Q. Was it old, prior to 1916, to produce toluol from cymene?

A. Possible, but I think not—except by myself.

Q. The reaction was not known?

[fol. 309½] A. The reaction, I think, was not known.

Let me answer that question, in a moment. Yes, I knew it prior to 1916. I knew it in 1915, but I think it was not published—I knew it, probably, as early as 1914, but I don't think it was published earlier than that.

Q. You were the originator, or the inventor, or the discoverer of that reaction, were you not?

A. Not the general reaction, but I was, I think, the inventor of getting it from the crude product, one of whose constituents was cymene.

Q. Now, let us go back a moment. You used the word "generally." Was it not known, prior to any work which

you did, that by the use of aluminum chloride a certain amount of tolulene would be obtained from cymene?

A. I don't think so. I wrote a letter to my patent attorney and asked him to have a search made, and he didn't find it, and I then asked him to make a patent application, and the Patent Office didn't find it. I don't know, now, whether there was, prior to 1914, such knowledge.

Cymene was a rare chemical up to the time that I found that it could be had in quantities, as a by-product from the paper mill industry, and the cymene obtained from there, I might add, is quite an impure product, known as spruce turpentine.

Q. This work of yours that you speak of, resulted in your patent, No. 1,244,444, did it not?

A. Yes, and in other work as well, which did not eventuate into patents.

Q. But you did not purport in your patent, did you, to be the discoverer of the production of toluol from cymene.

A. No, the product, from which we make the toluol was known as spruce terpentine, and cymene was a name of the pure chemical, which was a high priced chemical, being worth, roughly, 90c. an ounce, whereas, the spruce terpentine, which I found could be used in this way, was worth about 10c. a gallon.

Q. But you claimed the process with reference to the spruce terpentine, irrespective of whether the process had been previously known with reference to cymene, which was a constituent of spruce terpentine?

A. I did not do the claiming at all; my patent attorney wrote it. I told him all I knew regarding it and he prepared the patent application and carried it through to issuance.

Q. Were you purporting to set forth there a general type of reaction or to point out a suitable raw material which would be affected by this re-action?

A. Neither one.

[fol. 310] Q. Then, in your own words, what were you purporting to do?

A. To give a process which might be commercially used to furnish toluol that was so much wanted for explosive purposes, toluol at that time being worth in the neighborhood of—well, the price varied, but it went as high as $7.50 a gallon, though the peace price of it is something like 25c. a gallon.

Q. And this patent of your is for an alluminum chloride cracking process, is it not, or in any event that was the kind of cracking process which it employs?

A. Yes, I think that is correct.

Q. And was it the process of this patent that you said was used during the war for making toluol?

A. It was.

Q. When did its use begin?

A. I am not certain that I can give the exact date. The company was organized and capital paid in, in, I think, July, 1916. The plant was designed, including the bubble tower and such as other apparatus there, immediately there following, say, in the summer of 1916. It went into operation somewhat later, perhaps May or June 1917, and it ceased operation when the price of toluol dropped to about $1.20 a gallon.

Q. Was that after the war or before?

A. That was before the end of the war, but only just before the end of the war.

Q. What was this company that you speak of, was it the "New Process Gasoline Company of Philadelphia?"

A. It was.

Q. Is that company still operating?

A. No, this was simply a war-time industry.

Q. Did this New Process Gasoline Company make any gasoline?

A. It was a name that was, in part, camouflage, because we did not want people to know that it was making raw materials for explosives, but it gave the idea that if the process continued after the war it would make gasoline in the sense of taking a naphtha and adding some propane to it, thereby making it a better gasoline and permitting it to make a profit on that kind of an operation. This——

Q. Now, with this plant—I beg your pardon.

A. (continued). This propane being a by-product formed in the manufacture of toluol.

Q. This plant that you have spoken of, of the New Proc- [fol. 311] ess Gasoline Company, was that the plant which you said in your direct examination that you designed for cracking processes and of which you were operating vice-president in charge of operations?

A. It was.

Q. And the only cracking that was carried out was this aluminum chloride cracking?

A. Yes.

Q. For making toluol?

A. And propane.

Q. And propane, yes. It was all made from the spruce terpentine?

A. Yes.

Q. Is spruce terpentine a hydrocarbon oil?

A. About 85 per cent of it is hydrocarbon and about 15 per cent of it carries oxygen and sulphur and other products.

Q. What is the boiling point?

A. Being a mixture it has no definite boiling point.

Q. What is the range of boiling points?

A. If we distill it, the first product to come over is some dissolved sulphur dioxide, together with a small amount of oily materials, whose compositions I do not know. Following that, the temperature quickly rises to about 175 degrees and stays between that and 185, until about 85 or 90 per cent of the material has come over, as the remaining ten per cent is distilled, the temperature rises rapidly, going as high, and even above, 250 degrees Centigrade.

Q. Prior to 1916, or prior to 1914, it was known, was it not, that hydrocarbon oils could be usefully treated by the aluminum chloride cracking method?

A. McAtee had, I think, a crocking process for use of petroleum oils using aluminum chloride.

The Friedel-Crafts re-action using aluminum chloride has been known for many years, it is useful in university laboratories. I do not recall that it had at that time been used commercially, except as a cracking scheme for petroleum.

Q. In your work on spruce terpentine, did you apply the aluminum chloride process in any manner different from that in which it had been previously applied in the cracking of hydrocarbon oils?

A. Do you refer to the Friedel-Crafts scientific work in universities, or do you refer to the McAtee process?

Q. Anything that had been known with reference to aluminum chloride cracking processes prior to that time?

[fol. 312] A. Applied it differently from what was cus-

tomary with the university scheme of using Friedel-Crafts re-action. I do not now recall how McAtee and the Gulf Refining Company used or carried out the aluminum chloride scheme for the cracking of petroleums, and I am not certain that I ever knew. So far as the university method is concerned, our plant method was to heat with a steam heated coil and passing through the mass of the mixture a current of hydrochloric acid; whereas, in university work we always heat the container externally and heat it to a quite moderate temperature.

Q. That is not so much different that you claimed it to be anything peculiar to you, is it?

A. The claims, as I stated, were written by the patent attorney, not by myself.

Q. Does the process of your patent, No. 1,124,444, or of any other known aluminum chloride cracking process, throw the slightest light on the thermal cracking of hydrocarbon oils?

A. It throws much light on the question of the cracking of oils, but so far as the thermal cracking of oils, it only indicates that certain groups will go off easier than others. If they go off easier chemically, we would expect them to go off easier thermally by pyrogenesis. Furthermore, this use of propane would be another advantage from the question of motor fuels, though it does not throw particular light on the question of pyrogenesis or thermal cracking oil.

Q. Do those that go off easier chemically, in fact, go off easier in the thermal processes? I am talking about the cracking of hydrocarbon oils?

A. Yes, if we are using oils of ring structure. If we are using hydrocarbons of ring structure, such as are present in Russia and California petroleums, and to a less extent in practically all petroleums. It does not help much when it comes to the straight chain compounds.

I made no claim in this patent that this discovery was epoch-making in the way of motor fuel production.

[fol. 313] Q. Doctor, do Pennsylvania crude oils contain some sulphur, either free or combined?

A. A very small amount.

Q. In what form is that sulphur, is it sulphur hydrocarbon?

A. I cannot speak from personal knowledge as to what form it is there, but my impression is that it is present as in combination, not directly with hydrogen but with carbon; that is, as a mercaptan, and thio-ether type of product.

Q. And under heating does that combination break up?

A. Not to the same extent that it does with other oils, such as Texas oil. It does break up in part but only in part; not near to the same extent as in the case with some other oils.

Q. And if it breaks up it leaves the sulphur free with the resulting product?

A. It may or may not. It may break up the original molecule carrying the sulphur, breaking into two molecules, one of which is free from sulphur and the other carrying sulphur; or, on the other hand, it may break up in such a way, for example, as to be given off as hydrogen sulphide, as is quite common with the Texas oils.

Q. It makes a very bad odor?

A. Not at all as compared with mercaptan, which would be in the other organic product.

Q. Does this breaking up of the sulphur carbon or the sulphur hydrocarbon molecule occur more readily than does occur the breaking up of a molecule of hydrocarbon to form a lighter hydrocarbon, or does it break up with more difficulty?

The Witness: Let me ask Mr. Neave what he means by sulphur hydrocarbon molecule.

Mr. Neave: I asked you if it was sulphur hydrocarbon and you said you thought it was merely sulphur, carbon—

The Witness: No, breaking between the sulphur and carbon.

The Master: Breaking between the sulphur and carbon?

The Witness: Yes, going into different directions.

Q. I am referring then to the breaking of the bond between the sulphur and the carbon; does that occur more readily or less readily than the breaking up of a hydrocarbon molecule in a cracking process to produce a lighter hydrocarbon?

A. That depends upon the oil used; that is, upon the compound that is being considered or broken. As I said a moment ago, in the Texas oil, in general it does; but in the

Pennsylvania oils I do not know and I think it does not, but I am not at all certain.

Q. You mean that it does not break up more readily?

A. More readily than some types of carbon compounds that do not carry any sulphur. In general, I may say, that compounds which we are quite familiar with in organic chemistry, carrying many types of elements, for example, carbon, hydrogen, sulphur, nitrogen, phosphorus, such as protein, are more easily decomposed than those which are of simpler character, and particularly smaller size.

Q. So that the general rule is that the bond between the sulphur and the carbon breaks up more readily?

A. No, I do not know that that is true. I said that the compounds decompose, but I do not know that they decompose between the carbon and the sulphur.

Q. Then, do you mean that as a general rule, the sulphur compounds do not break down first?

A. No, I said that as a general rule, the compounds carrying a considerable number of elements, carbon, hydrogen, sulphur, hydrogen, phosphorus, break down easier than those which are of simpler constitution, I simply say only two, such as carbon and oxygen or carbon and hydrogen; but as between compounds carrying carbon, hydrogen and sulphur, and compounds carrying carbon and hydrogen, I think we would find cases where the sulphur would break off easiest and other cases in which the sulphur would remain attached to the carbon, and we would get a breaking between carbon and carbon rather than between carbon and sulphur.

A good illustration of that would be in the case of the [fol. 314] Texas oils where you get ready breaking between carbon and sulphur, setting free the hydrogen sulphide; whereas, in many other oils, we get, after our cracking process, considerable amounts of carbon, hydrogen and sulphur compounds formed from large molecules, carrying carbon, hydrogen, sulphur.

In other words, there is no breaking between the sulphur and the carbon but it must be understood that in each case there probably is some of the other.

In other words, that such reactions do not go 100 per cent; they go partially and the other reaction may go to some extent also.

Q. Then you do not know of any general rule as to the relative ease of decomposition of sulphur compounds and the simpler hydrocarbon compounds?

A. I would say that I feel that there is no general rule as to ease of decomposition. If there was, it would be carried out to get hydrogen sulphide in cracking oils, because it is so much easier to remove in refining. I mean, if they all cracked like the Texas oils, and instead of having to go through the customary treatment for such oils, say, as Ohio oils to get rid of the sulphur, a very complex and rather expensive treatment.

Q. Can you say definitely that some or certain of the sulphur hydrocarbons will break down more readily than the simple hydrocarbons?

The Witness: Will the reporter read the question?

(Question repeated by the reporter.)

The Witness: What do you mean by "sulphur hydrocarbon"? A hydrocarbon is a compound of carbon and hydrogen, and "sulphur hydrocarbon" is a new term to me.

Q. I thought you had used it.

A. No, I do not think so.

Q. What are the bonds between the sulphur and the carbon that you have been talking of?

A. They are a transfer of electrons.

Q. Well, they are bonds between the sulphur and the carbon?

A. Not in the present-day chemistry. We speak of them as a transfer of electrons.

Q. Well, it seems to me you spoke a moment ago, did you not, of the bonds between the sulphur and the carbon?

A. It is a term that is used and has been used and can still be used if we use it in the older sense.

[fol. 315] Q. All right. Now, I have been calling the sulphur hydrocarbons those compounds in which the sulphur was bound to the carbon, which I supposed was what you called the compounds——

A. By all of its valences, or would it be partly bound to hydrogen?

Q. Any way you wish. Now, I am asking you whether there are not certain of those combinations that you can

say surely will break down so as to break the bonds more readily than the simple hydrocarbons break down to form lighter hydrocarbons?

A. Judging from the fact that we readily get off hydrogen sulphide from a number of Texas oils, I would say that there are such compounds, using the term, "Sulphur hydrocarbons," in your sense; and the fact that we do not get it in any such proportion from Ohio oil, I would say that there were some which did not.

Q. Is Texas oil peculiar in that respect, or is that not the general rule with reference to all the oils?

A. I said a moment ago in connection with that, that in general these re-actions took place not exclusively—when heating an oil not exclusively in one direction; that is, there would be some of each action taking place in heating an oil which would carry sulphur.

Q. This hydrogen sulphide that you speak of is a very offensive smelling thing, is it not?

A. Yes, when dilute it is very offensive, but not any more offensive or anywhere near offensive as the mercaptans which I mentioned earlier, the first time I think I mentioned hydrogen sulphide.

Q. At the bottom of page 335, and the top of page 336 of the printed record, you were speaking of a publication relating to the work of Kier, and you say, "that the fact that he has stated in that publication that his product had an odor far more offensive than crude oil shows to us of the present day that he was cracking his product."

Are you certain of that or was he merely, by heat, breaking some of these sulphur bonds and getting off the sulphur decompositions which are very offensive in odor?

A. From our general knowledge of the small percentage of sulphur contained in Pennsylvania oil, such as Kier used, and from the fact that it was by repeated distillation that he got this, the hydrogen sulphide would have gone off by the first or second distillation, and, in fact, in [fol. 316] the amounts present in Pennsylvania oil, the amount after a second or third distillation being given off, would be very small.

Further, he is wanting to make an illuminant of it, and such hydrogen sulphide would have gone off far earlier and with the lighter portions; hydrogen sulphide being a gas at ordinary temperature, and he wanted here what we

call kerosene; that is, illuminating oil; and accordingly, there is little or no basis for thinking that the odor here was due to hydrogen sulphide, or in using such an oil as Pennsylvania petroleum, that it was primarily due to the mercaptans which might be present in insignificant quantity, but he is carrying out a process by repeated distillation, which would be an atmospheric cracking process, and as such it would give those products which are said to give, and do give to cracked gasoline—not only gasoline but illuminating oil, an unpleasant odor, as compared with the straight run saturated hydrocarbons, such as the Pennsylvania oil on straight distillation might have given or as it had in the original oil.

Q. Kier was merely trying to purify his oil, was he not, and make an illuminant of it?

A. Yes, I should say so. He was trying to get rid of the heavy products and also the light products, so that he could use it in place of what we speak of as kerosene now.

Q. From what sources did you obtain your information as to what you call "Kier's work"?

A. From Crewe's "A Practical Treatise on Petroleum."

Q. How do you spell that?

A. C-r-e-w, published in 1887, but written essentially by him before his death of November, 1885, and at pages 134 and 135 gives rather a detailed discussion of these items in connection with Kier. Shall I read it?

Q. No, I will look it up. You did not give the reference before in the direct testimony.

A. This work was done, so Crew states, in order to make a fluid suitable for burning in lamps.

Q. How many years were you at the College of Wooster in Ohio, and when did you leave there?

A. I was two years at Wooster, Ohio, and I graduated, leaving there in 1895. I also later took a Master's work by spending some time in there in the summers.

Q. What were you specializing in there, if anything?

A. What was your question?

Q. What were you specializing in at that time, anything?

[fol. 317] A. Chemistry and mathematics, and I was assistant in the chemical laboratory during the last year of that time.

Q. And then, when did you go to the University of Chicago?

A. I first went to the University of Chicago the 1st of June, I think it was, or the 3rd day of June, 1897, was there for only the summer and taught in the succeeding year and came back and later entered and continued through several years.

Q. When did you leave there, about?

A. How is that?

Q. When did you leave there?

A. I left there in June or August, I am not certain which (I think August) 1900, though I did not take my final examination until the spring of 1901, receiving the degree of Ph.D. in 1901.

Q. And when did you go to the University of Berlin?

A. I was in Berlin for only a part of the summer semester, reaching there, I think, June 4, 1906, according to my recollection.

Q. What were you doing between 1900 and 1906; just generally, I do not want it in detail.

A. I was teaching chemistry at Lake Forest University, Lake Forest, Illinois.

Q. What kind of an institution was that, I am not familiar with it.

A. It is a co-educational college of ordinary type, coupled with several other institutions. I was in the college part.

Q. How long did you stay in the University of Berlin? You say you went there in the summer of 1906.

A. I said, only for the summer semester of 1906 and not quite all of that; I was late in getting there.

Q. Then, where did you go from there?

A. I went back to Lake Forest and taught there for several years.

Q. Until when would that be, about?

A. I left Lake Forest in the summer of 1909 or 1910—I can count it up in a moment. 1909. In Lake Forest I had been head of the Department of Chemistry. I went from there to the University of Maine, as head of their work in chemistry and chemical engineering, leaving there in March, 1916. Do you wish these later dates, may I ask?

Q. Oh, yes; I do not care for the months.

[fol. 318] A. (continued). I came down to New York in commercial work with the Tennessee Copper Company in charge of their research work, and was with them exclusive time, or nearly exclusive time (I was allowed to do

certain outside consulting work) until October, 1917. Since 1917 I have been at Columbia University in the Department of Chemical Engineering, though I have retained my relations with the Tennessee Copper Company, being ranked as Chemical Engineer for the New York office of the Tennessee Copper and related companies.

Q. What articles have you published dealing with hydrocarbons and forms of petroleum, other than the book entitled "Shale Oil"?

A. I can not give from memory details regarding these, but I should say that there are some half dozen articles and three or four patents. I think probably there are more than that: there are three with Lider, two with Goodwin, at least three by myself in the way of articles, and possibly as many as six by myself, and several patents.

Q. Were they mostly on shale oil?

A. Mostly, yes, though not all of them.

Q. Not all of them. I do not suppose you have a list of those here.

A. I have not.

Q. But could you readily get them for me and let me have them tomorrow?

A. I haven't the list even in my office. I would have to simply go back through the journals and chemical abstracts for them. Your group can get them just as easy as I can.

Q. Have you testified as an expert in any suits relating to petroleum?

A. I do not believe I have actually testified; I have given advice in one or two.

Q. Have you at any time been a consultant to any corporations working in petroleum?

A. Yes.

Q. Which ones?

A. I do not recall the name of the corporation but in connection with the Gartlan process of oil cracking in Ontario, in connection with a shale oil petroleum process which was being tested and run in Long Island somewhere. It has been three or four years ago.

Probably, in a minor way, I have collected fees for con- [fol. 219] sulting work for four other companies primarily concerned with shale oil work; two of them are Colorado firms and others were people that simply came to me and asked me definite questions in my office and I do not know

the location of the firms, and——

Q. What was this Ontario work you speak of?

A. That was on the question of a cracking process which I mentioned in my direct testimony there, of cracking in which pressure was used; a vapor phase affair. I should say probably a total of seven firms or seven different consulting jobs, and possibly I may be in error; it may be as low as six or it may be as high as ten.

Q. That is altogether, you mean?

A. Altogether.

Q. Now, this Ontario work, can you give me any more definite information as to what company that was for?

A. I could tell you so that you could locate it though I can not at this instant give the name of the company. The people I have referred to were the people who were making whiskey at the Walkerville, Ontario, plant, and I have forgotten their names.

Q. What work did you do in that connection?

A. I spent up there perhaps five or six days advising them and discussing with them. I do not think I am at liberty to give you details as to that work.

Q. What process were they using there, was it a patented process or a published process?

A. It was not a published process and the patents had not at that time issued, and I do not know that they have since issued.

Q. Is the work still proceeding?

A. I am of the impression that it is but I am not certain.

Q. How long ago were you connected with it?

A. Oh, about four years ago.

Q. This shale oil work that you said you were consulted about, was that a cracking process?

A. All shale oil work, practically, is cracking work.

Q. What character of cracking?

A. You have to crack your material which is in the shale in order to get oil out from it. You have to crack that product if you get a light boiling product from that. The first product in the shale is not oil. If you heat that gently we can crack out and get ammonia and carbon dioxide and have [fol. 320] left a product which is sort of like a heavy vaseline; and on further heating, that becomes a petroleum oil by a simple cracking process; and, ordinarily, in shale retort work, both of those processes are carried out at one

step. Further work on that shale oil in the way of redistillation or rerunning of it, cracks it still more and we get a change in the question of percentages of unsaturated products and so on.

Q. Was that all shale oil cracking with which you were connected a thermal cracking or was it an aluminum chloride cracking or something of that sort?

A. All that I have been connected with, with commercial companies, was thermal cracking. I have done some work in my laboratory in connection with aluminum chloride cracking and other catalytic agent cracking.

Q. What were they producing in that Ontario plant?

A. They were studying a cracking process.

Q. They were not producing anything?

A. It was not a plant for the purpose of buying oil and cracking it and selling the gasoline; it was a plant which was studying the question of cracking by this scheme.

Q. A cracking of the same kind we have been talking of here?

A. Yes, though by a somewhat modified scheme; that is, it was a thermal cracking but not a liquid phase cracking; it was vapor phase cracking.

Q. Were they not trying to make benzol?

A. No, they were trying to make gasoline or motor fuel

Q. It was Hiram Walker & Sons, was it, who was behind that?

A. No, the Walkers do not own that plant and have not, I think, for ten or twelve years. I think it is some other name. The plant is called the Hiram Walker and they gave the name to Walkerville plant, but I think that is somebody else has owned the plant from a period of say 1915 to 1920, and that was the group that owned it in that period who were financing this cracking process.

Q. Is this shale oil, obtained in the way that you have described, a hydrocarbon oil?

A. Yes, it is a hydrocarbon oil; it is a petroleum.

Q. Is it of a character identical with that of American petroleum?

A. Some of it is as close to some kinds of American pe- [fol. 321] troleum, as some kinds of American petroleum are close to other kinds of American petroleum.

In other words, almost every well petroleum field varies, and, similarly almost every shale oil field varies in the kind

of oil that it gives. The products made from it go on the market and sell in competition in the same way as those made from well petroleum.

Q. Does shale oil re-act in the same way as well petroleum?

A. Re-act towards what? We have always got to have a second material when we speak of re-acting.

Q. In its cracking characteristics?

A. Yes, in the sense that while it has some highly unsaturated molecules to start with, and on cracking we get smaller molecules, the final product obtained is essentially the same as in cracking of well petroleum; that is, in well petroleum we approach it from a product that is fairly well saturated, and on cracking we get a mixed product carrying similar amounts of unsaturated: In the case of shale oil we start with a product which is ordinarily more saturated, and we get, on cracking, the same or about the same percentages of unsaturated. In other words, in both cases we work towards an equilibrium, towards the same point, and it would be true that if we took the saturated products from shale oil and cracked them, we would have identical products as we get from cracking well petroleum, and, similarly, if we took the unsaturated products from well petroleum, we would get the products identical with those we obtain from shale oil. In other words, the two give you the same products by the same process, and the processes of cracking are the same in the two.

Q. In the process of fractional distillation, can you separate from shale oil the same products that you separate from crude petroleum?

A. Yes, but the proportions are not always the same; are not normally the same.

Q. As I understand what you have said, the shale oil has in it much more of the unsaturated compounds than has the well petroleum. Now, if that is so, how is it that you can get from fractional distillation of shale oil the same products that you get from well petroleum? What becomes of the unsaturated compounds that were originally present in the shale oil?

[fol. 322] A. I said you got the same but in different proportions.

Q. I do not quite know what you are applying the word "proportions" to?

A. In different percentages. In other words, from shale oil you can get, and Thorpe and Young did get, octane, nonane from the cracking of paraffin from shale. In other words, from shale oil, they get octane and nonane, which are identical with the octane and nonane obtained from well petroleum, such as Pennsylvania petroleum, or as almost any other petroleum.

Q. Thorpe and Young, in obtaining this product, started with the paraffin which was the saturated portion of the shale oil, did they not?

A. That paraffin was not saturated, it was only partially saturated. It was the ordinary paraffin identical with that obtained from either material, but they call attention to the fact that it is only partially saturated.

Q. But they were not starting with the shale oil, were they?

A. They were starting with a part of the shale oil. You have also——

Q. May I ask you right there, Dr. McKee, whether Thorpe and Young were not starting with the most saturated portion of the shale oil?

A. No.

Q. Which portion was more saturated than the portion they started with?

A. If they had distilled and gotten out, for example, the octane, it would have been a gasoline product that would have been far more saturated.

Q. Is there octane in shale oil?

A. Yes.

Q. How do you know that?

A. From the boiling point of gasoline obtained from shale oil. I have a product which it happens to be that I was working with in my laboratory—I am volunteering now, possibly.

[fol. 323] I have a product which I was working with in my laboratory during this past summer, made in New Jersey from shale gasoline and it has a boiling point so that it carries octane. We took it also and removed the unsaturated hydrocarbons, and while we did not exactly isolate a pure octana, we showed its definite presence.

Q. Would it be correct to say that shale oil resembles petroleum somewhat but is by no means identical with petroleum?

A. Absolutely not.

Mr. Myers: Do you mean not identical or not true to say that?

The Witness: It would not be true to say that.

The Master: That is, because the petroleum has such a large number of constituents?

The Witness: Yes. We now know so many types of petroleum, whereas a few years ago we only knew Pennsylvania petroleum.

Q. Have you got your book here on shale oil?

A. I have.

Q. You have?

A. Yes, sir.

Q. Let me see it, please.

(Book produced and handed to counsel by the witness.)

Q. I find, in your book on shale oil, page 130, the following:

"Speaking generally, the crude oil produced by the destructive distillation of oil shale, resembles petroleum, somewhat, but it is, by no means, identical with petroleum."

Is that a correct statement?

A. Let me see the book, please. This is a chapter which I did not write, and which I have discussed, this viewpoint, with Mr. Hamor, who did write it, and a man with whom I differ very decidedly as to some phases of oil shale. I didn't write this at all, it must be borne in mind.

Q. And you don't think that statement is correct?

A. Read the statement, please.

Q. "Speaking generally, the crude oil produced by the destructive distillation of oil shale, resembles petroleum, somewhat, but it is, by no means, identical with petroleum." —is that a correct statement?

A. I think it is partially true, referring to the crude oil as at first obtained, inasmuch as it is somewhat higher in [fol. 324] unsaturated products. But that is not the question you originally asked me, in your previous question.

Q. What was the difference in the questions, as you understood it?

A. You asked me whether it was identical with, and I told you that—you asked me—that wasn't the wording of it.

Q. In my question I quoted that sentence in your book,—that is, that shale oil resembles petroleum, somewhat, but it is, by no means, identical with petroleum.

The Master: You said, "would it be fair to say."

The Witness: And I said that, in general, it would be fair to say that it was identical, but here is a statement by other persons—another person, a man from Pennsylvania, who is perhaps thinking of Pennsylvania petroleum, primarily.

Q. Then we can not take all these statements that we find in books as being one hundred per cent correct?

A. Absolutely not.

Q. Can a satisfactory heavy lubricating oil be made from petroleum?

A. Yes, sir.

Q. Can it be made from shale oil?

A. I have seen the statement that it cannot be, but Lider, who is a chemical engineer, and especially in charge of the largest shale oil plant in this country, has written me that it can be, and Lider was formerly a student of mine, and got his Doctor's Degree on shale oil.

I have not seen such a product. We have very valuable light lubricants, but not heavy lubricants.

Q. From shale oil?

A. Yes.

Q. On page page 26 of your book you say, and express the view that a satisfactory heavy lubricating oil cannot be made?

A. So far as your question goes, you have misquoted me. It is "has not been made."

Q. Are the cracking of petroleum and shale oil entirely parallel processes?

A. This implies that shale oil is not type of petroleum, which—with that exception I should say that they are essentially the same processes, but I do not want, in replying to that, to state that shale oil is not a type of petroleum. In fact, the term "petroleum" was used for shale oil, for many [fol. 325] decades—for many generations—before it was used for well petroleum. Well petroleum has later swiped the name, in America, though it has not, elsewhere.

Q. That use of the word "petroleum" that you have just referred to, was the early use of the word in England, was it not?

A. And in France and in this country.

Q. That is, petroleum in the early days, as a word, was used to include shale oil and similar rock oils?

A. They were all petroleum and have remained so, even in this country, up to the time that shale oil ceased to be made in this country, and for some little time—I will say a decade following that. At that time the American petroleum industry took over the word and has since used it as if shale oil was not petroleum.

Q. On page 81 of your book on shale oil, you find, do you not, that there is a statement to the effect that the cracking of petroleum and shale oil are not entirely parellel processes?

A. Yes, in the same sense as I answered you, twenty minutes ago—the fact that in the cracking of the shale oil we go from a product largely unsaturated to a product partially unsaturated, and in the cracking of well petroleum, we approach the same point from the higher saturated products as the starting materials, and a higher unsaturated product as the final product, the same point, essentially, being reached in the two, or by the same process, in the use of the two materials.

Q. When highly unsaturated shale oil is cracked, are the results obtained just the same as those obtained with the cracking of petroleum?

A. The cracking of what petroleum?

Q. By petroleum I am meaning oil well petroleum.

A. Which one—Mexican, Texas, or——

Q. Any of them—any of them you choose.

A. The resulting products obtained are nearer to the products obtained in the cracking of some well petroleums, than the products obtained in the cracking of other well petroleums.

[fol. 326] Q. But when highly unsaturated shale oil is cracked, do I understand you to mean that the results obtained are of the same character as those obtained in the cracking of petroleum?

A. I must ask you to tell me what you mean by result—whether you mean the product obtained, or the yields obtained, or some other thing. Your question is indefinite, so far as the meaning of "result" is concerned.

Q. I was not thinking so much of the yields, as I was of the products obtained and the methods of obtaining them;

A. The products obtained are the same, essentially, as those obtained in the cracking of well petroleum.

The Master: Do they come within the class?

The Witness: Yes, sir, they come within the class.

Q. And obtained in the same way?

A. Yes, by similar cracking schemes.

Q. On page 81 of your book on shale oil, you say, do you not, that when highly unsaturated shale oil is cracked, the results obtained are apparently just the reverse from those obtained with petroleum?

A. Yes. I was speaking of the question of the passing from unsaturated to saturated, whereas, in the well petroleum you pass from saturated to unsaturated, but the products—which is the question you asked,—and that is why I asked you for the definition of the word "result"—are the same.

Q. Well, is that statement on page 81 of your book, correct?

A. The word "results" in that sentence, is not used in the sense of the products.

Q. In what sense is it used?

A. The result, in one case, here, is that highly unsaturated shale oil being cracked, the results obtained are the change from unsaturated to saturated, whereas, the reverse is true with reference to those obtained with well petroleum—we pass from saturated to unsaturated. But the final products are the same.

[fol. 327] In other words, if you have a product that was thoroughly cracked, from well petroleum—from some well petroleum—not all—and a product that was thoroughly cracked from some shale oils, you could give it to an analytical chemist and he couldn't tell the difference between them.

Q. The statement in your book is correct, is it?

A. Yes.

Q. And it means, does it not, that there is something radically different in the action, or the reactions in shale oils, as compared with petroleum?

A. No, it does not. It means that you simply approach the cracked products from one direction in one case, and another direction in the other case—that is, from unsaturated to partially saturated—we will say fifty per cent

saturated, and fifty per cent unsaturated, and from the product which is eighty per cent unsaturated to start with —whereas, in the case of some petroleums we start with a product which is eighty per cent saturated, and some twenty per cent unsaturated.

Q. You certainly would not say the two reactions are the same, when they were just the reverse would you?

A. I might say that I do not think they are the reverse. In the cracking of your oil, if you have a compound, there, which is a highly unsaturated compound, we will say carrying thirty carbon atoms—I mean an unsaturated compound, carrying thirty carbon atoms, and you cracked that and got three compounds which carry ten carbon atoms, two of which are unsaturated, and one saturated, you could get that from shale oil, and you could get that from well petroleum.

On the other hand, if you started—as you do in each case —with a product that is carrying, say, thirty carbon atoms as a saturated compound, and crack it, and get two compounds of ten carbon atoms each, that are unsaturated, and one that is saturated, you will have the same products—you would have had the same process, and you would start with the same materials, but you would have had, in the shale oil, more of one kind of one of these compounds, and less of the other—more of the unsaturated carbon atoms, and less of the saturated. In the case of the well petroleum—say it is Pennsylvania oil—you would have more of the saturated and less of the unsaturated in a thirty carbon atom product. The processes acting on the molecules, are the same. It happens to be that the raw materials differ [fol. 328] in the percentages of these constituents—just as well petroleums differ in their percentages of their constituents.

One would not speak of a Mexican oil, a California oil, and a Pennsylvania oil, as being identical, and having the same constituents, in the same proportions, or the same percentages.

Q. Am I right in understanding from what you have said, that cracking improves shale oil, while it degrades petroleum oil?

A. No, I should say that it improves both, inasmuch as we want gasoline at the present time, and we do not want gas oil, or crude oil, so much. Gasoline is worth more per

gallon than crude oil, or gas oil, and, as such, it improves the product.

Q. Well, by cracking of the shale oil, I have rather gathered from what you have said, that you get a better gasoline than if you had not cracked, while, in the cracking of petroleum, I gather from what you have said, that you get a better gasoline than the gasoline you get from petroleum that is uncracked—is that right?

A. Yes, and no. If you, for example, take a Mexican oil, you will get no gasoline if it is uncracked, and from shale oil—some shale oils, you will get no gasoline unless it is cracked.

Q. I am talking of quality rather than quantity.

A. You didn't say so.

Q. I said better—I didn't say more. Tell me about the quality?

A. Kindly repeat your question.

Q. In the cracking of shale oil, do you get a better quality of gasoline than the gasoline that you get from shale oil without cracking?

A. I presume in each case you are considering the passing through the ordinary chemical treatment after the cracking process, as well. You will get a better odored product from your straight distillation of petroleum, than you will by your cracking process. But, on the other hand, you will get less miles per gallon from your straight distillation product, than you will from the cracked product. So, depending on which way you take it, one is better or poorer, and in the case of shale oil, you get a product, which is of the type of the high mileage per gallon, rather than of the pleasing odor. Most of us, however, do not buy gaso- [fol. 329] line, at the present day, as perfume, i. e., for its odor. So that cracked gasolines, probably, are really as good or better than the straight run distillation, though that has not been the trade viewpoint, in times past.

Q. Do you mean that a cracked gasoline is different from the uncracked?

A. Yes, in that it contains a larger percentage of unsaturated products.

Q. And better than the uncracked?

A. Better from the economical side—that is, more miles per gallon.

Q. You are talking, now, in answering the question, with reference to gasoline obtained from well petroleum?

A. Or shale oil, either one.

Q. Does shale oil contain no constituents that are not in well petroleum? That is, do the two have exactly the same constituents, though in different proportions?

A. I do not know. I have been working with certain of the nitrogen contents of shale oil, earlier, in the belief that they did not occur in well petroleum. I have lately been informed that in certain minor fields we are finding these same nitrogen constituents—such as cholodine.

Q. Does well petroleum contain unsaturated hydrocarbons?

A. Judging from analyses which have been published, yes.

It is a question as to whether, for example, the Pennsylvania oil carries unsaturated hydrocarbons, as a crude oil. It apparently does, though, when attempting to distill for straight distillation, we always get a product, which will react with bromine, for example, and show a bromine number in straight distillation, and presumably, that was present in the original petroleum, though it might have been obtained by cracking, during the simple case of distillation.

Certainly some of the well petroleums carry a fair amount of unsaturated products. If we take the crude petroleum and give it the ordinary sulphuric acid test, for example.

Q. Are there any compounds in crude petroleum that are not in shale oil?

A. I don't know of any.

Q. How about asphalt?

A. We have, from certain of the shale oils, rather heavy asphaltic products—in fact, the ordinary shale oil is spoken of as an asphaltic material, though there are exceptional ones that are high in paraffin.

[fol. 330] Q. Is there asphalt in shale oil before it is cracked—that is, are the asphalts in shale oil produced by cracking, or may it be separated by a fractional distillation?

A. If we take the shale oil as it is directly distilled from the shale, we will find that it carries, in many cases, considerable amounts of asphaltic material—in other words, in the crude shale oil.

Q. Can asphalt be volatilized?

A. Asphaltic materials can be, but I don't know just what you mean by asphalt as an individual material, there—whether you mean Trinidad asphalt, or products of that kind, the Trinidad asphalt being that which is best known among raw asphaltic materials.

I will say that I think I know a little more regarding this than I intimated. I would say that aphaltic material can be volatilized. The work of Streeter, carried out under Professor Hixon, of Columbia University, has shown that asphaltic material can be volatilized, and that it will dis-associate into other products, and can be polymerized again, to form true asphalt materials. That is true even in such materials as Trinidad asphalt.

Q. Can you volatilize these asphaltic compounds without decomposition?

A. According to this work of Streeter you can, to a minor extent, but only to a minor extent. Ordinarily we would say not.

Q. On page 81 of your book on shale oil, I find the statement that well petroleum contains no unsaturated hydrocarbons—is that a correct statement?

A. That is not a correct statement, if it is there. Pardon me—wait until I find it. A man named Goodwin, of the Standard Oil Company of New Jersey, was co-operating in this chapter.

That is not quite correct. Moreover, this, you will note, is a discussion, here, of this equilibrium phase that I spoke of sometime ago—perhaps an hour ago—in which we are starting, in one case, with products which are highly un-[fol. 331] saturated, and reach an equilibrium product, and in the other cases we are starting with products which are highly saturated, and I have stated, there—I say, "I"—Mr. Goodwin is equally responsible for it—as if the well petroleum was completely saturated, thinking, as we were, of the contrast in that approach to this same equilibrium.

Q. Now, shale oil contains saturated and unsaturated hydrocarbons, and relatively large amounts of oxygen, nitrogen and sulphur compounds, does it not?

A. Ordinarily, yes—not always.

Q. It contains as much as 50 to 80 per cent of unsaturateds, does it not?

A. Ordinarily, yes—before refining—that is, as the crude product, and before cracking.

Q. And what percentage of unsaturateds would you say were present in well petroleum?

A. I answered that question a moment ago, when I said that they varied very considerably in the percentage of unsaturated, and that some of them, for example, the petroleum of Pennsylvania, contained a very small percentage, whereas, other products were fairly high, judging by the sulphuric acid test, which is the customary test for unsaturated products.

Q. What do you mean by low and fairly high?

A. I cannot give numerical results there, but I should say that in the general range, anything that was from 1 to 15 per cent I would speak of as low, and anything higher than that, as high. I am not even certain as to just what percentages each of these oils might give.

Q. What is the highest percentage of unsaturateds that you have ever known in any crude oil?

A. About 85 per cent in some shale oil—shale petroleum.

Q. How about well petroleum—what is the highest you have known in that?

A. I have never studied that definitely. I never made that investigation. I have simply a general knowledge of that.

Q. Then you did not study it, at all, at the time that you wrote this article that we have been last referring to, in your book, when you said that well petroleum contained no unsaturated hydrocarbons?

A. I did study it partly. Goodwin had been in the oil refining work for the Standard Oil Company of California, [fol. 332] and for the Standard Oil Company of New Jersey, and I depended upon him to check that phase of it, as he was a co-author of this part of the book.

Q. You thought that he knew more about it than you did?

A. No, but if there was an error there, he ought to have caught that phase of it. We were not, primarily, concerned, but, with the amount of unsaturated, and the maximum amount of unsaturated present in any well petroleum. We were concerned, here, with the question of the course of this reaction—as to the chemistry of this reaction

—as is shown by the reading of the entire paragraph, rather than the isolated phrase, which you mention.

Q. What knowledge have you, even now, as to whether that statement in your article is correct or incorrect, as to there being any unsaturateds in well petroleum?

A. I have stated here, that this is, in some sense, incorrect, because, for example, I have quoted, here, in these last few days, analyses by Allen, of straight run distillates. Let me quote that again.

The Master: Just refer to it. It isn't necessary to put it in the record again.

The Witness: I want to give the percentages, your Honor, on that.

Where a straight run gasoline carried a bromine number of 17.9 per cent, the naptha, 18.3 per cent, the illuminating oil, 34. per cent—I cannot think that all of that could have been brought about by cracking.

Q. Have you any knowledge as to whether Allen's statements are correct?

A. I did not analyze representative commercial samples of English oils, as he did. Allen, probably, is as high an authority in the matter, as anybody in the world, so far as making analyses is concerned.

Q. A higher authority than you?

A. Yes, as an analytical chemist.

Q. Is the treatment of gasoline from well petroleum, to remove gum-forming compounds, and so forth, the same as the treatment of gasoline from shale oil, for the same purpose?

A. What do you mean by the "and so forth"?

Q. You can leave that out, if you want to, and just confine your attention to the gum-forming compounds.

A. Yes, I think so—though there is a difference in amounts, and differences, possibly, in the temperatures used.

[fol. 333] Q. To remove gum-forming compounds from shale gasoline, you have to use more distillations and more treatments than in doing the same thing with gasoline from well petroleum, do you not?

A. Not necessarily. You can, as the Elko, Nevada, plant did, do that, but you can, on the other hand, use more chem-

ical treatment and remove them. You can take your choice, as plants do in well petroleum work.

Q. And there is a great deal more loss in the treatment of shale gasoline by sulphuric acid, is there not, than in the treatment of gasoline from well petroleum—isn't that true?

A. Are you referring to straight run distillation petroleum, or are you referring to cracked petroleum?

Q. Answer it as to both.

A. In the Scotch results there is, they having attempted to obtain a product more nearly parallel to the old type of straight run petroleum distillates. In the case of the cracked gasolines of well petroleum, which is made by thorough cracking of petroleum, the losses would be approximately the same.

Q. Just what would be the losses in each of those cases?

A. I don't think I could answer that, because your well petroleums differ very greatly among themselves. Your degree of cracking differs, there, and I haven't the statistics for any particular plant, at hand. But the statement that I made is a general statement, which is correct.

Q. Well, you know the Scotch shale industry, don't you?

A. Somewhat.

Q. Can you give the figures with reference to it?

A. I cannot, excepting this, perhaps, that their total losses run in range, not of gasoline alone, but in the treatment of their other products, and their making of paraffin, and carrying it clear through to the making of candles, their total losses run in the range of 20 per cent—perhaps 25 per cent.

The Master: What do you mean by losses, in that sense?

The Witness: Products that, if they start with a hundred gallons of crude material they will only sell 75 per cent of finished material. Part of it is lost as gases, part of it is lost by evaporation with gases, part of it is leakage around the plant, part of it is coke, and all other losses—so that, starting with a hundred gallons of crude products—of crude shale products—they would get 75 per cent of that volume, or of that weight, as salable products.

[fol. 334] Q. Would you get paraffins as a salable product?

A. Yes.

Q. Can't you give us any idea of the amount of losses in the treatment of crude shale gasoline?

A. I have a student sitting back there who has carried out that work in the last six weeks, but I cannot give you those figures.

Q. But what are the losses in the industry?

A. In the shale gasoline?

Q. Yes.

A. I don't know. I have only the figures for the total shale oil.

Q. Haven't you any idea what the losses are in the treatment of the crude shale gasoline—whether it is half of 1 per cent, or 5 per cent, or 10 per cent?

A. I should say that they were—that it would depend on which scheme you used for carrying through your process. You might use a distillation scheme which will mean more handling, but not very expensive handling, and that will give you, by repeated distillations, a product which will have fairly high losses, or you can use certain types of chemical treatment, which will give you very low losses, and I should say that perhaps your variation between those types would be from—that the losses would be in the range of 1 per cent, and that the highest might be carried out with as—I mean the highest type of process might be carried out with a loss of 10 per cent.

The choice depends, somewhat, on the cost of your chemicals at a particular plant, or your other factors, what your market is. In Scotland we will want a more highly saturated product than we would use in America. Accordingly your question I feel is impossible of exact answer.

The Master: The experience of one plant might not be the experience of another plant?

The Witness: I think there are no two plants that probably run within—oh, there are many plants that are—not many plants, because there aren't many shale plants in the country—but the plants will vary among themselves as much as within the figures I have mentioned.

Q. Are there any commercial shale oil plants in this country?

A. There is a plant at Elko, Nevada, which has a capacity of a hundred barrels a day, and connected with it is

[fol. 335] a refinery which has approximately that capacity. That is the Catlin Shale Products Company, which is essentially owned by the New Jersey Zinc group.

There is another plant that calls itself a shale product plant, and I think their capacity is larger—in California—in which Dr. Day, who lately died, was actively interested.

Q. That was an experimental plant, wasn't it?

A. No, I think they are about the same capacity, though I am not certain about that. I have not seen the plant.

Q. How long have those two shale oil plants been operating?

A. Shale oil plants have been operating since 1832, at least.

Q. I mean, those two.

A. The Catlin plant was started over ten years ago, and the California plant, perhaps two or three years ago—possibly. I am not certain. As I say, I have not been at this plant. I should say, however, that the Catlin plant is probably older than ten years ago—perhaps it was fourteen years ago, since it was started.

Q. Can you tell, from your theoretical knowledge, and your chemical knowledge of shale oil and shale oil gasolines, what the losses would be?

A. I should say that if you do not consider as losses, in this case, the removal of the nitrogen compounds, which may be done with ten per cent sulphuric acid, that the losses would be essentially the same as with a cracked well petroleum gasoline carrying the same percentage of unsaturated compounds—that is, depending on the degree of the well petroleum cracking process.

Q. Can you deal with all of those petroleums and cracking processes purely from the theoretical aspect, without having any knowledge of commercial results?

A. No. There are certain phases——

The Master: Deal with them in what respect? Do you mean discuss them?

The Witness: I can discuss them.

Q. My intention, from the question, was to ask whether you could, from your theoretical knowledge, safely predict, or estimate to what the commercial results would be—or the practical results would be.

A. No. For example, on the question of the mining costs—the mining costs have, in general, had very varying [fol. 336] estimates made by various people, and those estimates run all the way from 20 cents a ton of shale to $2 per ton of shale—the extremes probably being given by people who knew least about the mining industry—and the mining phase of the oil shale plant, of course, is one of the large expenses—perhaps the largest single expense of an oil shale plant. That would be one cost that you can't readily take from the theoretical end.

We do know, of course, of some analogies which we can use—for example, the analogy of coal mining—and that shale will take more dynamite than coal, but that it will make less fines, and as the fines are normally unused in the distillation process. We can estimate, but the estimates are very crude estimates, when made from the theoretical side.

One of the things which the Catlin plant has considered very important in its work, has been the determining of the actual cost of mining shale in a vein of the character of their vein.

Q. On page 90 of your book on shale oil, published in 1925, I find the statement with reference to shale oil plants, that, "no commercial plants are yet in operation in this country"—is that statement correct or incorrect?

A. Mr. Karrick, who wrote that, and who was from the Bureau of Mines of the United States Department of the Interior, at that time, did not count a hundred-barrel plant as a commercial plant, he considering only a commercial plant, one that would make, say, several thousand barrels a day—in other words, a larger plant than the—I say several thousand—perhaps five thousand barrels a day—larger plants, for example, than the Scottish and French plants—so far as American procedure is concerned.

Q. I was wondering how you knew that that was his point of view.

A. I have talked with him and discussed that point with him.

Q. That is, you went over these various articles with the people who wrote them, before they were published in your book.

A. I went over them before they were published in the book. I also, have discussed that particular phase with Mr. Karrick, since this book went to the printer.

Q. You accepted Mr. Karrick's opinion on this matter, when you issued this book under your name, did you not?

[fol. 337] A. No. There are quite conflicting statements between various men, in the various chapters, and there was no attempt to make any man follow any other man's opinion.

Q. Isn't Mr. Karrick, or Professor Karrick, an authority on this shale oil proposition?

A. Karrick is probably the man who has carried out more of the analytic work of shale oil, than anybody else in the country, but other than on the methods of analysis, I should say that he was not a particularly high authority on shale. This chapter, however, is on the factors in analyzing the shale oil.

The Master: Whether shale oil can ever become commercially practical, would depend upon whether it can go into volume production, or not—isn't that true?

The Witness: Yes, it practically means that as to the price of crude oil—whenever crude oil reaches a certain price, then shale oil will probably go into production.

It is the difference between the cost of the crude oil from shale and crude oil from well petroleum, in particular communities. In France and Scotland, they carry out the operation of these shale oil plants under a profit.

In the United States the price of crude oil has not yet raised to a point where shale oil promises to be—when used simply as motor fuel—a profitable manufacturing enterprise.

The Master: The Morning Times carries a statement that the crude oil production of the United States will fail in twenty-five years. That prophecy was by an Englishman, promptly contradicted by another Englishman.

The Witness: It is interesting to note that last year the production was less than the year before, though our consumption is, in general, increasing at the rate of fifty million barrels of oil per year.

Q. Is it the fact that some unsaturated compounds, such as some of the olefines, are not objectionable in gasolines, while others, such as the diolefines, are objectionable?

A. I think that is correct, the diolefines being the products which we ordinarily say resinify on standing, particu-

larly when exposed to light and air. They are the products which I mentioned in my earlier testimony, as being polymerized by treatment with a metallic sodium, such as the process Thorpe & Young give.

Q. Shale oil products have an odor considerably different from petroleum derivatives, and more disagreeable, do they not?

[fol. 338] A. Yes—than straight petroleum derivatives—due to the nitrogen compounds and to the large percentage of unsaturated compounds, and sometimes due to the presence of rather large percentages of sulphur compounds.

Q. The shale oil products are more highly colored than some products from petroleum, if excessively refining losses are to be avoided, are they not?

A. Yes, if we would leave in our nitrogen compounds, and this would be particularly true if such a shale as the Colorado shale is used, carrying fourteen per cent—I say fourteen per cent—an average of fourteen per cent of nitrogen compounds.

These nitrogen compounds are color producing, and of course they cannot be removed without giving a loss of that fourteen per cent.

Q. Then you think it is correct to say that all well petroleum and shale oils are identical in character?

A. In general, yes. I gave a case, a moment ago, of the highest I know of, in nitrogen compounds. There are others, such as from Ione, California, that carry practically no nitrogen compounds, and in that case we would have hydrocarbons free from nitrogen, and essentially the same in that case as in other cases, we would have no essential difference. The Colorado one, that I refer to, having fourteen per cent of nitrogen, is the base material, and is an oil carrying the highest content of such nitrogen and sulphur basic compounds.

Q. When you say two things are identical in character, what do you mean by the word "identical"?

A. I mean that they carry the same constituents—not that they have the same proportion of those constituents. In other words, if we would add sugar to water, we will have it that both of them are of sugar-water mixture, and are identical in that respect. One may carry sixty per cent of sugar and another may carry eighty per cent of sugar in

the syrup, but they would still have the same materials present, and would be identical, in that sense.

Q. In the sense that commercial alcohol is identical with gin, for instance?

A. I am not a drinker of gin, and I don't know. I don't know the composition of gin.

Mr. Myers: Oh, I object to that, your Honor.

Q. Petroleum is a mixture of a great number of different hydrocarbons, isn't it?

A. It is.

[fol. 339] Q. And these different hydrocarbons can be separated out by fractional distillation, can they not?

A. In part.

Q. What do you mean by "in part"?

A. For example, if you would take two products having the same boiling point, or within, say, one degree, I don't think we can separate them by fractional distillation.

Again, if we will take hydrocarbons of high melting point, such, for example, as paraffin, I don't believe we can separate them by fractional distillation. They will decompose while we are separating them.

Q. Now, will you please describe the process of fractional distillation? Let us see just what it is; you may as well apply it specifically to a crude oil.

A. In the simplest type it will consist of placing the oil into a container, which is closed excepting for a pipe outlet to a condenser. The condenser will be cooled with a suitable liquid, say, water for low boiling liquids. Heat will be then applied to the exterior, and particularly the bottom, of the vessel or still. The product will be brought to boiling, vapors will pass off from the liquid through the pipe into the condenser. The lower boiling portions will go off first, but there will not be, in a simple distillation process such as I am describing, an exact separation of this condensate into products whose boiling point is a close and definite one, that is, within say 1 degree. As the process proceeds, the lower boiling portions are removed, the medium boiling portionus begin then to distill off as the temperature of the still increases, and the condensate will be higher boiling. This process will be continued so that the next products will be still higher boiling and we may have, as we got towards the latter part of the distillation,

[fol. 340] products which would even solidify in the condenser coil. In such a case, we would use not cold water but either hot water or some warm liquid to bring about the condensation. There would be, ordinarily, some residue left in the still which would not distill. This is the simplest type of distillation.

If we wanted to make a better one, we would put some type of a reflux on the still or expose the still head to partial cooling to air. If we wanted to improve it still more, we might carry out the distillation in vacuum.

If we wanted to improve it still more, we would perhaps use steam in place of vacuum, or even simultaneously with vacuum.

If we wanted to improve it still more and make more accurate separations, we would put on a reflux of complex type, such as a bubble tower with a dephlegamator; and if we wanted to improve it still more we would take the fraction which had come over at one time, say the first 5 per cent or 20 per cent, and redistill through such an apparatus as I have last described. This would give us what we know as fractional distillation.

In such a process as just described, there would ordinarily be some accompaniment of cracking, particularly in the latter part of the process. The use of vacuum, or the use of steam would decrease this cracking; the use of a dephlegamator would increase it.

Q. What are the principle commercial products contained in petroleum and separable by fractional distillation? Please list the commercial names in the general order of their boiling points.

A. These will vary in the different sections of the country, but, in general, I think we can say that in all of them we would have gasoline as a first product; kerosene as the second; gas oil as the third; light lubricating oils, heavy lubricating oils, cylinder oils. These lubricating oils, in general, having to go through a process of chilling and pressing to remove the paraffin wax. The paraffin wax then itself becomes a commercial product. We have the use of the still wax a small amount there; and, finally, the coke is sold.

Those are the major divisions. Of course, we have various grades of gasoline; we have various grades of each

of the other products; in other words, we can subdivide those products.

[fol. 341] The Master: Where does naphtha and benzine come in in that list?

The Witness: We have, in the case, for example, of naphtha, a distinction, whether we are working on the west coast or east coast of the United States. Naphtha, in one case, is the crude product, the crude gasoline; and benzine, in one case, is counted as the crude gasoline before chemical treatment, and on the other coast, the reverse is sometimes used.

Q. Are the cylinder oils the heaviest products generally distilled from the crude?

A. No, still wax. Cylinder oil will float on water; still wax will sink ordinarily below.

Q. And still wax is distilled from the crude, is it?

A. Yes, or from the residue after the other products have been distilled.

Q. And the cylinder oil is the next to the heaviest product distilled from the crude, is it?

A. In the distillation you get off paraffin wax as a very heavy constituent, a thick constituent of the oils there, and it may even solidify when chilled down to a point that you can not pour it. I do not think cylinder oil ever solidifies to the point where you cannot pour it.

Q. Does the paraffin wax distill over before or after the cylinder oil?

A. In general, the paraffin wax comes over with the lighter lubricating products; that is, ahead of the cylinder oil, but from some of your oils you will get oil which is of the character of cylinder oil simultaneously with the wax.

Q. What book was it you consulted in giving that answer?

A. I was looking but did not find in Bell's American Petroleum Refining.

Q. The cylinder oils do distill over, do they not? They vaporize and distill over when they are condensed?

A. Not in some oils, but we would get a product which is used as cylinder oil from some distillates, though it is minor in amount. Not from, for example, Pennsylvania oils, do we ordinarily get the cylinder oil distilling over, [fol. 342] but we use it as a residue.

Q. The still wax distills over, does it not?

A. That is the case where you run your distillation to coke, but you asked me to give you the various products which had commercial uses.

Q. And the still wax does distill over?

A. Yes.

Q. And before that the cylinder oils would distill over, would they not?

A. They would probably be somewhat cracked in that process and would be lighter in viscosity than they are when used directly from the still without being distilled over.

Q. This paraffin wax that you have referred to, it has always commanded a higher price in the market, has it not, than gasoline?

The Master: Pound for pound?

Mr. Neave: Yes.

A. I am not certain of that, because paraffin wax, for example, is selling for around, say, 5 cents a pound, which for gasoline would be the equivalent of about 33 cents. We have had gasoline selling in this country for 33 cents. In Europe, I am inclined to think that it sells for less per pound.

Q. I beg your pardon; had you finished?

A. No. For gasolines it is relatively as expensive. I have seen it, for example, selling in England for four shillings, six pence a gallon. To be sure, that is the Imperial gallon rather than the United States gallon and somewhat larger, but that would mean the equivalent of 60 cents a United States gallon; 55 to 60 cents a United States gallon; and that is, of course, a higher price per pound and would be, roughly, 9 cents per pound, which is a higher price per pound than the paraffin.

Q. When gasoline has been selling at 33 cents a pound in this country, what was paraffin wax selling for at the same time?

A. I do not know definitely but I think it was not far from the present day price. I do not think the demand was for paraffin wax; I think the demand was for only one product in petroleum. I would not be certain of that, though.

Q. You have just described this process of fractional [fol. 343] distillation. That separates, as I understand, from the oil, the products that are already there, is that it?

A. That is correct, but in addition we do get some cracking.

Q. That is, with the heavier fractions?

A. Essentially with the heavier fractions.

Q. And the gasoline that is obtained in this process of fractional distillation is what we have spoken of as the straight run gasoline, is it not?

A. Yes, about which I quoted an analysis from Allen, showing that it was partially unsaturated.

Q. What is the boiling point of gasoline?

A. The United States requirements are that it shall come over below 225 Centigrade, which would be 437, I believe, Fahrenheit. I will check that figure. Yes, 437 degrees Fahrenheit.

Q. Would you say the boiling point of gasoline was 437 degrees Fahrenheit?

A. No, that is its maximum. It is a mixture of materials which will be partly low boiling and partly higher boiling, but the maximum for the ordinary, specified work is 437 degrees Fahrenheit, but was formerly much lower. That is, gasoline was formerly more volatile than it is at present.

Q. You were asked in your direct examination as to the difference between motor spirit and gasoline on the one hand, as I understood the question; and the original material that was started with. You replied that "motor spirit is one which is volatile enough to be used without difficulty in the present day automobile engine." Were you there using "motor spirit" as synonymous with gasoline so that your answer is, in effect, a definition of gasoline? The portion of your testimony to which I am referring is on page 340 of the printed record.

A. Yes, only in general terms, and in particular as applying to the products which are being discussed in the citations of the prior art. I had just been discussing Engler's work earlier.

Q. Is volatility the only index of what constitutes gasoline?

A. No.

Q. What else is there?

A. In times past we considered as its principal index [fol. 344] the gravity. There are still other requirements regarding a gasoline besides even the density or gravity and volatility.

The density was formerly the most important, today, the distillation range is the most important requirement in defining gasoline.

Q. Well, today the matter of gravity has been wholly abandoned in connection w-th gasoline, has it not?

A. No.

Q. It does not enter at all into the consideration of what is gasoline?

A. No.

The Master: Are you referring to chemically or commercially?

Mr. Neave: Commercially.

The Witness: No, it is not. For example, if you go to a corner filling station, they will discuss with you and say that one of them may be a higher gravity than the other, and that is not correct, not wholly. It has, largely.

Q. The gasoline should not be discolored, should it?

A. In times past, the requirement was for an almost colorless product. This then was called water white. A product which carried some color was called standard white. At the present day, those color requirements have lowered, so that at the present day, even the so-called water white is far from being a colorless product. It has a yellow tone to it.

Q. The gasoline should have chemical stability, so as not to color on standing or become gummy on standing, ought it not?

A. Yes, speaking to a minor degree.

Q. How volatile must the gasoline be to be used without difficulty in the present-day automobile engine?

A. It depends somewhat upon the engine. There are engines that can use heavier, that is higher boiling products, than other engines, so that in general we cannot make a flat answer as to the requirement for the present-day automobile engine. The present-day automobile engine is

better in its ability to use higher boiling products than the engine of ten years ago, very much better.

Q. But the gasoline is sold irrespective of what engine the gasoline is to be used in, as I understand it, and how volatile must the gasoline be to be used without difficulty in the various engines that come along?

A. I am quite certain that if somebody would bring up [fol. 345] an old car of fifteen years ago and try to use it on many of the gasolines that are sold today, they would be likely to have trouble. At the present day, I would say, though, that there is essentially no particular difficulty in using gasolines which have a range with a maximum distillation point of 437, and which have the other requirements of boiling of say fifty per cent at a certain lower temperature, such as the specifications that I have mentioned to you. Those percentages, however, have varied from year to year, always going up.

Q. If you had a gasoline, all of which boiled at 100 degrees Fahrenheit, could it be used without difficulty in the present-day automobile engines?

A. I am not an automobile engine expert.

Q. Would you approve that gasoline as a motor fuel to be sold generally in the market?

A. No, it would be a dangerous thing to have around the community. It would be dangerous to have an open vessel within the distance of twenty feet of a man smoking a cigarette, for example.

Q. If you had a gasoline, none of which boiled, say, below 430 degrees, could it be used without difficulty in the present-day automobile engine?

A. I think not.

Q. What fractions boiling at points higher than 100 must gasoline have so that it may be so used?

A. I said a moment ago that I was not an automobile expert with knowledge as to the freak material which would [fol. 346] hail at blood temperature, that is 100 degrees Fahrenheit, and which would be a gas and not a liquid in our summer days. I do not think anybody has any knowledge that can answer that question. It is a hypothetical question which has not, probably, been tested out.

Q. What are the standard specifications of present-day gasoline?

A. They will vary somewhat according to who is giving the standards, whether it is some State standard or a City standard or a Navy standard or some other standard.

I have before me the boiling point ranges as the gasolines were actually sold and meeting the several standards as obtained by the Bureau of Mines, Department of Interior, for the several years, 1915 to January 1925.

The Master: Averages?

The Witness: The averages of a large number of samples purchased in the open market and representing, essentially, the commercial product of those days. For example, in 1915, the maximum end point which I have given as 437 was 370 Farenheit.

Q. Was how much, I beg your pardon.

A. Was 370. The point where 90 per cent of it came over was 310; where 50 per cent of it came over, 225; 20 per cent, 180 and the starting point was 100 degrees Fahrenheit, where the first drop came over.

Now, coming down to 1925, January 1925, while 437 is the limit, the actual gasolines on the market averaged 425. I say, its limit on one specification, the Navy specifications. 90 per cent came over at 382 instead of 310, ten years earlier; 50 per cent came over at 266 instead of 225, ten years earlier; 20 per cent came over at 195 instead of 180 ten years earlier; whereas, the starting material, the initial, first drop came over at 95 degrees instead of 100 degrees, five degrees lower. In other words, a few degrees below those temperatures instead of a few degrees above those temperatures. That, I think, answers your question. I believe it was primarily concerned with the distillation range.

Q. And the various standard specifications, such as the Navy specification, requires, does it not, that certain proportions shall boil over at certain temperatures?

A. Yes.

Q. And those temperatures are not only the starting [fol. 347] temperatures and the end temperatures, but also certain intermediate temperatures?

A. Fifty per cent and ninety per cent, as I recall it. I do not recall whether twenty per cent of the figures I have given has an intermediate temperature or not.

Q. Yes, it has an intermediate temperature.

A. It has. Thank you.

Q. Now, why is it that in these standard specifications there is any requirement that certain portions shall boil over at various temperatures, not only the beginning temperature and the end temperature but intermediate temperatures?

A. Because if there was not a certain amount of low boiling product, that is, below twenty per cent, we will have difficulty in starting the engine in cold weather. On the other hand, if we made the maximum boiling point lower, we would decrease the supply of gasoline and we would, accordingly, make the price per gallon higher. So that the attempt is to leave in as much as can be left in of the higher boiling portion, and yet, at the same time, get enough of the more volatile portions which will permit explosions to take place in the cylinder, even in cold weather.

The Master: I suppose, without blowing up your tank in the rear end of your car in hot weather?

The Witness: Yes. If it was all even approaching 100 degrees Fahrenheit, or any large proportion, you would be riding on a steam boiler ready to explode.

Q. You said in your direct testimony that there were certain earlier specifications differing from the present-day specifications; what were the earlier specifications?

A. For example, I think the latest specifications given in Bulletin 15, Kansas City Testing Laboratory, published in 1919, I think has a somewhat lower distillation range.

In 1919, it apparently was 220 instead of 225 Centigrade for the end point, which would be 428 Fahrenheit, for a motor gasoline, but that is not given as I expected to get it, as a Navy specification there. The largest difference, however, was not in the top, 220, or final distillation, but in lower boiling portions.

Q. Dr. McKee, perhaps I can bring you to the point more quickly if I tell you just what part of your direct examina- [fol. 348] tion I was referring to. You were saying that

there are in certain specifications limits at which fifty per cent or ninety per cent of the gasoline comes over, and then you said, the "earlier specifications, however, do not have those intermediate limits"; page 182 typewritten record.

The Master: Without going back to hunt it up, what had you in mind when you answered the question?

A. I think I would like to have the context, but my impression is that I had in mind, first, the question of the present-day with the ninety per cent at a certain point and as it was in 1919, ninety per cent at 438, and 1915 at about 325 degrees, and earlier than that (and this is what I was thinking by the word "earlier") there were no specifications, or essentially so, for that, if we go back say to the time where gravity was the requirement rather than volatility was the requirement.

Q. That is, you meant there were no temperature limits, no boiling point limits in the earlier specifications you were referring to, the portions of which I quoted?

A. In the earlier ones, such as I quoted from Crew of 1887, and of Allen—well, Allen is a little later—the gasoline was sold on gravity instead of volatility, but there were variations and the variations were around, from 1925 to 1919, to 1915, and it was only about 1915, possibly a little earlier than that, that the Navy specifications came in on boiling point range.

Q. Present-day gasoline and kerosene overlap somewhat do they not; that is, some of the fractions being below 437 are in kerosene and some boiling above 437 are in gasoline?

A. I think I know what your question means but I would have to answer "no" to that. I think, instead of the word "fractions," you mean "substances." If you mean "substances," I would say yes.

Q. I will accept your amendment. How much is that overlap; between what boiling point does the overlap range?

A. That will vary somewhat with whether you are working on oil, say, in a California refinery or in an East Coast refinery.

Q. I do not care for it exactly, just give it to me approximately.

A. Furthermore, it will vary at the present day, whether they are using a bubble tower scheme or not, but in general, I think it would be something like—there are materials in kerosene that boil even slightly lower or somewhat lower than 400 degrees Fahrenheit; and there are materials prob- [fol. 349] ably in gasoline which we could get out if we carefully went after them, which will boil as high as 450 or 475 degrees Fahrenheit. It would require rather careful analytic work in either case to isolate the materials.

Q. Well, the ordinary Engler distillation will show an overlap, will it not?

A. Some.

Q. How much do you mean by "some," approximately?

A. I do not recall any work that I have ever done or that I have seen printed regarding just what that overlap is. I could guess but it would only be a guess.

Q. It is about fifty degrees; you have given it here, between 400 and 450; is that about right?

A. No, it is more than that, if you take it your exact way and not for the Engler distillation process.

Q. By the Engler how much would it be?

A. I stated a moment ago in answer to your last question that I have never tried it, nor have I seen it in print, exactly how much that particular piece of apparatus would give.

Q. Then you have no idea what the boiling range of gasoline is?

A. Oh, yes, I have an idea.

Q. What is it?

A. (continued). But not a direct idea with the particular instrument you have mentioned, as to just how many degrees that overlap is.

Q. You have given us the boiling point ranges of kerosene——

A. No, I have not.

Q. I beg your pardon; of gasoline. Now, can you not give us boiling point ranges of kerosene?

A. Possibly I can find it for you.

Q. It is not necessary for you to take time looking it up unless you want to, Dr. McKee. Of course, we can find

that. But you do not know what it is; you do not know what the boiling point is?

A. We ordinarily carry out our distillation so that the end point of our gasoline fraction is around 420 to 430, and that meant when we distill it there will be a little of it that will come over a little higher than that.

The Master: He is talking about kerosene.

The Witness: Yes, and kerosene begins where the gasoline leaves off, your Honor.

[fol. 350] Q. But you say there is an overlap?

A. There is an overlap in the boiling point of the constituents. There is not an overlap as your question was originally framed, that is, of the fractions; but I answered it and suggested a correction, and you accepted my correction, and then there is an overlap of the substances.

Q. An overlap of the substances. And generally speaking, how much is that overlap in degrees?

A. I have said, and this is a more exact answer, perhaps than you want, in the kerosene you will have some materials boiling even below 400, though the upper end point of gasoline is 437, and similarly, in the gasoline, by careful analytic work, I would expect to be able to find materials, some of which would boil as high as 450 degrees Fahrenheit, or even possibly 475 degrees Fahrenheit.

In other words, there are materials in the kerosene boiling below 400 and in the gasoline boiling between 450 and 475 Farenheit.

Q. What is the ordinary initial boiling point of kerosene?

A. The cut is made in some refineries at 430 degrees Fahrenheit, so that whatever boils below that may be spoken of as gasoline; above that as kerosene.

Q. Then, do you mean by that, that the initial boiling point of ordinary kerosene is 430?

A. No.

Q. That was my question: What was the initial boiling point of kerosene?

A. The initial boiling point of kerosene will be where the first drop of the kerosene would come over in a distillation.

Q. And what is that?

A. I do not recall that figure for the present day specifications.

Q. Have you any idea how much of the kerosene comes off?

A. How much?

Q. How much of the kerosene comes off below 437 in distillation of kerosene?

A. I do not have in mind the figures as to the percentages of kerosene coming over below any particular figure.

[fol. 351] Q. Dr. McKee, am I right in understanding that the boiling range of what is known as kerosene overlaps, to some extent, the boiling range of what is known as gasoline?

A. There are constituents which are common to each and those constituents have, of course, their individual boiling temperatures, but as normally made in a plant, a cut or division is made and that portion boiling immediately above that is kerosene, and that below is gasoline.

Q. But those cuts are not absolutely, mathematically definite boiling points, are they?

A. No, they vary with different plants, and in fact, with kerosene the important thing is not the boiling point; the important things are the flash point and its burning qualities, whether it will form on the wick, the so-called toadstool, that is; or coke on the wick, whether it will climb the wick; that is, have capillarity sufficient to climb the wick. The boiling point is a factor of very little importance, almost no importance from the kerosene side compared with the question of flash point, of sulphur content, of the so-called burning test to see how much it would smoke, and the question of climbing the wick. In earlier times we put in a good deal of what is now gasoline into what was then kerosene.

Q. But in present day kerosene as gasoline there are some portions in each which have the same boiling points, are there not?

A. Yes.

Q. Now, are those portions, kerosene or are they gasoline?

[fol. 352] A. They may be either. We do not define kerosene, as I said a moment ago, primarily by its boiling point. For example, I think that if we take the Navy specifica-

tions for kerosene we will find that there is no lower limit or boiling point. There is an upper limit and there is a flash point which, indirectly perhaps, means as to the amount of low boiling materials, though not a determination of a lower boiling limit.

Q. In present day gasoline are there portions boiling at say 425, and do those portions also appear in present day kerosene?

A. To some extent, yes, in both cases.

Q. Now, would you call those portions boiling at 425, gasoline?

A. If they were in gasoline, yes. Gasoline is a mixture of products and not a single product. For example, as we were speaking this morning, of 100 degrees stuff, boiling at 100 degrees Fahrenheit, and at 437 degrees product. The gasoline is a mixed product in which we could take these individual products and then mix them up afterwards, but it is easier to take the whole mixture and simply use that portion which is satisfactory for the uses to which gasoline is put.

Q. But you do not have gasoline until after you have that mixture, do you?

A. We do not sell it as gasoline, if it is of 100 degree boiling material or if it is of 437 boiling material, it would not meet the needs under any or most of the State laws, or the Navy, or other country laws on gasoline.

Q. So that it is not gasoline, is it; it is only an element of gasoline, is it not, or a constituent of gasoline?

A. The 100 degree product would not be gasoline. It would be a refined constituent of gasoline. The 437 degree product, if it boiled between 436 and 437, would not serve as gasoline, because it would be too heavy, it would not, for example, have 50 per cent of it boiling below a temperature of say 310, or whatever the 50 per cent figure is.

Q. And the portion boiling at 425, say, is not a gasoline but it is only a constituent of gasoline, is that not true?

A. It is a constituent of gasoline, and I think that gasoline should be considered as—the term "gasoline" should be considered as a mixture of products, rather than as a single one; at least we commonly so do consider it. And we can make that mixture from the materials artifically by mixing them, or we can take it as it comes ready mixed from our well or shale oil petroleums.

[fol. 353] Q. Does present day kerosene contain any gasoline, properly speaking?

A. What do you mean by "properly speaking"?

Q. Accurately speaking, instead of speaking loosely.

A. Yes, much of it on the market, particularly that which has not been through the socalled better type or newer type of refineries, that which would be obtained by a simple skimming process without accurate or without complex bubble tower schemes of separation, for example.

Q. Does it contain gasoline or does it contain some constituent of gasoline?

A. It contains constituents of gasoline but enough of them so that probably the product, which if it was separated out carefully from them, would meet the laws, at least of some of the states, for gasoline. The putting in of the bubble tower scheme, has been for the very purpose of getting more gasoline out of the kerosene, increasing your gasoline fraction and decreasing your kerosene fraction, when these bubble tower stills are applied to such a mixture.

Q. Does the present-day kerosene contain any portions boiling below 300 degrees Fahrenheit?

A. I would like to ask from what plant you are considering it.

Q. What?

A. (continued). As the various plants vary to a consiedrable extent that will vary. I mean in their kerosene it will be different depending on whether you are taking a product, say from a skimming plant down in Texas, in which it will, or from some of the more complex plants in which it will not; so that your answer is "yes," and "no."

Q. What is the lowest boiling point portion of anything contained in the present-day kerosene?

A. I do not recall.

Q. What present-day kerosene can you take and separate out the portions by fractional distillation and obtain therefrom a present-day gasoline?

A. Probably from most of the present day, or from much of the present day kerosene made from Mid-Continent oil by skimming processes without the use of a bubble tower, and there are a number of such plants.

Q. And you would get present-day gasoline out of distilling that kerosene, would you?

A. You would get some, not much.

Q. What would be the boiling range of that gasoline?

[fol. 354] A. I do not know.

Q. How do you know it would be present-day gasoline?

A. I know that it would carry a small amount of volatile in the material, and we could, by taking that, as I said, get out further products which would have ranges low enough to meet the requirements of some of the states in the way of gasoline requirements.

Q. And it would be satisfactory for motor car fuel, would it?

A. Reasonably so, yes.

Q. You do not know what the boiling points would be?

A. I have never made such a product. I know the purpose for which the refinements, which have gone into use a few years ago, before your words, "our present-day limitation," came in, and those refinements were for the purpose of taking gasoline products and increasing the gasoline yield at the expense of the kerosene yield.

Q. Dr. McKee, the point I have in mind is this, and I do not quite see that there should be any difference between us. In kerosene as it is known today, it seems to me to have in it only some of the portions, which, when mixed with other things would make gasoline, and has not in it the thing that is gasoline, according to the specifications you have given; is that not true?

A. I do not think that that is true for much of the kerosene that is on the market. It is true for some of the kerosene; kerosene, as I said, which had been refined by the newer schemes. Perhaps I can answer your question by calling your attention to what the history of the situation has been.

If you take in, say, about 1880, about that period, we had sold upon the New York City market considerable quantities of kerosene, and that kerosene on later work was shown by Chandler to have mixed with it as high as forty per cent of the then gasoline; as the prices of gasoline have risen and of kerosene have fallen (and it must be borne in mind that the prices then were much higher than they are at present), we have the raising of the upper,

the distillation, point for gasoline, and the gradual increase in the yield in gasoline by straight distillation at the sacrifice of kerosene.

The upper point of the cut for kerosene has not changed to amount to anything but the gasoline has changed very considerably. So that, within a few years ago, say, three or five, seven years ago, we had, with most of our kero- [fol. 355] senes on the market, fairly good quantities of gasoline, and as the refinements and ability of the refiner, by using more complex apparatus, have permitted him, he has, as they say, cut into the kerosene in order to make more gasoline, and that cut-in has not been simply by taking out constituents of highest boiling point of the gasoline, but it has carried with it some of the medium boiling point products which had before gone over into the kerosene.

With the use, however, of the newer schemes, such as the bubble tower, we can make this cut very much sharper than we could by the old type still. So that, if we take the plants which are still working under the old type still, as some of them are, we still have the gasoline present to some extent in the kerosene.

Q. You have said that the kerosene of 1880 contained about forty per cent of the then gasoline?

A. That is not quite correct. I said that some of it contained it, as the analyses put out by Chandler from kerosene purchased in New York City markets, part of the gasoline was put in by the refiner and part of it by the grocer.

Q. Then you have said that some of the 1880 kerosene contained about 40 per cent of the then gasoline. What did you mean by that? Did it contain fractions or portions which boiled over a range amounting to forty per cent of the gasoline range, or did it have in it forty per cent of the material that was then known as gasoline?

A. It had in it approximately forty per cent of the material that was then known as gasoline, and in fact, in some cases it developed that we had made a kerosene and then added a gasoline to it to make another grade of kerosene.

Q. Now, did that kerosene of 1880 contain any of the present day gasoline? I am not asking you whether it contained any of the portions which go to make up present

day gasoline, but whether it contained any of the present day gasoline.

A. It did, because they have taken, in some cases, 60 gallons of the then kerosene and had added to it 40 gallons of the then gasoline, and that then gasoline would be counted as extremely good present day gasoline.

Q. Then your answer applies only to those situations in the making of kerosene in 1880, when they unintentionally took some gasoline and mixed it with the kerosene, is that it?

A. No, I said that was the maximum or approximately [fol. 356] the maximum. There were other cases in which they simply did not get out the gasoline but left it in the kerosene.

Q. You mean the cut was made at a higher temperature, is that it?

A. No, the cut was made at a lower temperature.

Q. The cut was made at a lower temperature?

A. Or more commonly, they used stills without any type or reflux or poor mechanical equipment and poor operation.

Q. This 1880 kerosene that you were speaking of, did you say that Professor Chandler had something to do with that?

A. Yes, it was done at the instigation and published as a bulletin of the New York City Board of Health.

Q. Was that prior to the adoption of any flash point regulations of kerosene?

A. I think not, but I think it was prior to the adoption by New York City of such flash point regulations.

Q. Where could I find that Chandler publication?

A. I do not know. I looked for a copy for myself just the other day but could not find it. But it is available, I imagine, in the New York Public Library, though I did not there look. The date of 1880 may be quite correct, it may be as early as 1877 or perhaps as late as 1885.

Q. Did the kerosene that was made in the early days otherwise than by mixing together gasoline and kerosene, contain any portions boiling at a temperature of say 430?

A. Yes.

Q. Any portions boiling at say 450?

A. Yes.

Q. And any portions boiling at say 400?

A. Yes.

Q. 300?

A. Yes.

Q. Any portions boiling at 100?

A. I do not think so. I do not know, though. At least, I do not know that it was ever shown definitely that it carried as low as that.

Q. Any portions boiling at 200?

A. I do not know, but I think so. I may be able to find Dr. Chandler's note books on carrying this out, because I have a number of those old note books of his. I have the office that he formerly occupied.

Q. In that old kerosene that was not made by mixing [fol. 357] gasoline and kerosene together, were there any fractions boiling at say 140?

A. I do not know.

Q. What is the lowest flash point permitted in present day kerosene?

A. It is lower than the kerosene is actually sold. What I mean is, that the present day gasoline, being the valuable product, the flash point requirement is a foolish requirement in as much as the manufacturer wants to sell gasoline and will rob his kerosene of those products which would give low flash point in order that he may merchandise gasoline. It is a requirement which was of some use 15 or 20 years ago, but at the present day is essentially a useless requirement.

Q. Then, what is the lowest flash point permitted in present day kerosene?

A. I do not know what the State laws of the various States are, but——

Q. What is the United States Government's specifications for kerosene, do you know?

A. I know in part but I do not recall what the flash point requirement is.

Q. Do you know what the lowest flashpoint was in kerosene of the elder days, such as of 1880?

A. I know that 15 or 20 years ago—about 15 years ago there was a flash point of 100 degrees Fahrenheit which was used, and there was another one of 110 degrees. 120 degrees Fahrenheit would be about 45 or 46 degrees Centigrade.

Q. 120 degrees Fahrenheit?

A. 120 degrees Fahrenheit.

Q. What do we mean by "flash point"?

A. Flash point should be determined or mentioned in connection with a particular type of instrument, say an open cup or closed cup, or a particular type of open cup or a particular type of closed cup; the scheme being to heat the oil, whose flash point is wished to be determined, gradually, and determine the point at which vapor is given off and at which those vapors will catch fire if a flame is moved into the vapor and air mixture; that is, if moved right across the cup. In the simplest type it would be simply a glass beaker heated and a match directed across there to see at what temperature you would get a flash of the vapors. There is another burning point which is known as the "burning point" which comes above the flash point and is that at which the oil will catch fire and continue burning and not simply the vapor flash.

[fol. 358] Q. What would be the approximate initial boiling point of kerosene having 120 degrees Fahrenheit flash point?

A. I do not recall. I do not know as I ever made such a determination.

Q. Would it be above or below flash point?

A. It is giving off vapor below the flash point—it must be giving off vapor below the flash point, or it could not flash, but on the other hand, as to what its boiling temperature is, where its vapor is 100 per cent, and one atmosphere,—that, I don't know—but it would be above the flash-point naturally.

Q. And it would be far above the flash-point, wouldn't it?

A. Not necessarily. There are many oils whose flash-point and burning-point,—and the burning-point is not far from the boiling-point—there are many oils whose flash-point and burning-point are quite close together—particularly lubricating oils.

Q. Flash-points and burning-points?

A. Yes.

Q. What about the flash-point and the boiling-point?

A. I say, the flash point would be fairly close to the boiling point. The boiling point is not a factor that is normally determined in the testing of kerosene. It is simply a creation of your own, essentially.

Q. Can't you calculate how much the boiling point of kerosene would be, above its flash point, its flash point being 120 degrees Fahrenheit?

A. No. If the vapors coming off were of a particular known composition, we might be able to calculate it, but we don't know it from the flash point alone. For example, our flash point represents a case where we have a mixture of vapors with air. If they are large molecule vapors they can be mixed in smaller percentages than if they are small molecules, in the vapors.

Q. Do you mean that you could not make a calculation, or that it could not be made?

A. I think I said that I could not. I doubt if it can be made correctly, but it possibly might be.

Q. Could it be made approximately?

A. You could make a rough determination, but it probably would have considerable inaccuracies.

Q. And could you do it roughly?

A. On certain suppositions I could.

Q. What kind of suppositions do you refer to?

[fol. 359] A. For example, the size of the molecules of hydrocarbons present in the vapor.

Q. And you don't know that with reference to kerosene?

A. No. It will be a mixed—there would be a mixture, and I don't know just what proportions those small molecules would have. I don't know how much hexane, decane, heptane, would be present. One way I think of doing it would be to—if we knew, for example, how much hexane was present——

Q. Have you made such a calculation?

A. I have, while I was answering that question.

Q. What was the result of that calculation?

A. That if it was hexane, the vapor pressure there would be about one-sixteenth of an atmosphere for the vapor, and then you can calculate, roughly, as to what would be the boiling point, but you would have a very difficult job to do it, without knowing, in addition, what the other liquids were, that were present there, because the remaining liquid is not hexane—it is a mixture of materials. If the vapor was hexane and it was flashing at 120 Fahrenheit, probably you could get out some liquid distillate between 200 and 300 degrees Fahrenheit.

If, on the other hand, it was not hexane, but was one of the other hydrocarbons—the larger ones—the boiling point would go up.

Q. What is the Navy specification of kerosene?

A. It is a kerosene which will, after burning for one hour in a lamp fitted with a No. 1 sun hinged burner, be tested photometrically, and five hours later another photometrical test will be made to determine any change in intensity of light. The maximum allowable loss shall be five per cent. It shall have at least, six candle power, when compared, photometrically, with an incandescent lamp, which has been standardized by the Bureau of Standards. It shall be a water white kerosene, and shall have a heating value of not less than twenty thousand B. T. U. per pound.

Q. You are reading from the——

A. From the book that I quoted from this morning—Bulletin No. 15, Kansas City Testing Laboratories. There are other specification, in addition to those I have given.

Q. Those Navy specifications contain a specification of the flash point, do they not?

A. Apparently not, from this. It is not given. There [fol. 360] are no other specifications given under kerosene, for the United States Navy.

Q. Aren't you familiar with the standard specifications of the Government, for gasoline and kerosene?

A. I am more for gasoline. Not for kerosene. I don't think that the kerosene specifications are particularly important. They seem to have no trouble with them.

Q. When was it that gasoline was wanted as a motor fuel—when you say the market wanted gasoline in larger proportions than the straight run gasoline would provide?

A. I should say at about 1915, was the point where cracking was necessary, in order to supply the market above what could be supplied by straight run gasoline—possibly a little before that.

Q. Well, there was gasoline on the market at that time, was there not, produced by cracking?

A. Some, but it was not any large proportion of it. There was gasoline on the market even twenty or thirty years earlier than that, produced by cracking.

Q. Where was that?

A. The Scotch shale oil gasoline, as described by Allen and others.

Q. Why was that cracked?

A. Because, in the making of gasoline from shale oil, all of it—the process is one of cracking—the whole shale oil industry has, essentially, a cracking process as a basis.

Q. Was the shale oil cracking process ever operated commercially, under pressure?

A. There are a number of such processes described, working under pressure on shale oil, but I don't know whether any of them ever went into commercial operation or not. Cracking could be without being under pressure, of course.

Q. Did you do anything with reference to filling the demand for gasoline, in excess of what the straight run distillations would give?

A. I have never been a petroleum refiner.

Q. Were you ever called upon to suggest or devise any means that provided a larger amount of gasoline than could be obtained by straight run distillation?

A. Yes, in my consulting work.

Q. When was that, first?

A. First, you say?

Q. Yes.

[fol. 361] A. My first consulting work was back in 1896, it was not in connection, however, with petroleum.

Q. When was your first consulting work in connection with producing more gasoline from petroleum?

A. About 1917.

Q. And what did you do?

A. Or possibly a little earlier than that, because the plant that I spoke of, was cracking spruce turpentine to get toluol, propane, as a by-product—a part of the plant was put in under my directions and it was discussed with the idea of increasing the output of gasoline, and particularly increasing the amount of low boiling fraction, which is the shortest in amount of gasoline.

Q. To produce it from what?

A. Using products which were rather too high boiling point to go on the market as gasoline, and they dissolved in them propane, to increase the ease with which they would be ignited and used in an automobile carburetor.

That was, perhaps, the first. The later ones were some of those cracking processes that I have mentioned—the Gartlan plant, in Ontario, and the shale oil plants in Long Island, and some of the western ones, which I did not go to, but their men came to me for consultation on certain problems, in seeing what could be done in the way of getting gasoline from the shale oil, and meet the market, which was showing up as the then shortage, of about 1920.

I have also had some things to do in suggesting to certain officials of certain oil companies, as to the output of plants, wishing to try out shale oil gasoline manufacturing.

Q. Now, are you through?

A. Yes.

Q. Your earliest work, apparently, was in 1917, to which you have just referred?

A. '16 and '17.

Q. Was that in producing gasoline from petroleum?

A. Not from petroleum.

Q. Well, that was my question. Now, what was the first work you did in producing gasoline from petroleum?

A. All the rest of them were from petroleum.

Q. And when was your first work, there?

A. The first work, I think, was in connection with shale oil petroleum, and in consultation with Mr. Catlin, of the Catlin Shale Products Company.

Q. And what time was that?

[fol. 362] A. That was probably, October, 1917, some eight years ago—in other words.

Q. And when did you first do any work in attempting to produce more gasoline from well petroleum?

A. About 1920, or 1921. This period being the period in which there was, perhaps, the greatest shortage of gasoline for the market.

Q. When did you first know of the use of the so-called Burton process?

A. I don't recall—possibly in 1915, or 1917.

Q. Do you know, now, when it went into use?

A. I don't know when it went into use.

The Master: Was your knowledge from the patent?

The Witness: No, my knowledge, that I am speaking of now, was derived from general publications in the chemical

field. I don't think I read the patent until probably 1922 or 1923.

The Master: Did the papers relating to chemistry, make publications with respect to this patent, after the patent had come out?

The Witness: I don't think so, regarding the patent, but I do think so regarding the question of the installation of the process.

Q. Were you familiar with the Willard Gibbs Medal that was given to Burton, in 1917?

A. Possibly that was the occasion for my knowing of the existence of the process, and its utilization, though I did not connect it, at the instant I was answering your question.

Q. When did you first read the Burton patent?

A. About 1923.

Q. And when did you first read the other patents of the defendants, to which you have referred me here—or the most of them?

A. I read, perhaps, a half dozen, or six to ten of them, at that same time, in 1923, and the remaining ones I did not read until after my connection with this case, which began officially, August 14th, of this year.

Q. When did you first read the Dewar & Redwood patent?

A. In 1923.

Q. In what connection was that?

A. I was studying the question of the cracking of shale oil, and simply was looking up some of this work in connection with my work with research students, at Columbia [fol. 363] University. It might have been 1922. It was in the summertime—I remember that. It was 1922, or 1923.

Q. On page 19 of your book entitled, "Shale Oil," I find the following—the book having been published in 1925:

"The percentage of gasoline obtained from crude petroleum has been considerably increased by new cracking methods."

What were you referring to there, as the new cracking methods?

A. The pressure methods, as distinguished from the old atmospheric cracking methods.

Q. In your direct testimony, on page 337, of the printed record, you have purported to picture tetradecane as having 14 carbon atoms—is that the same 14 carbon atom molecules, as the one to which you later referred, when you showed that it would be a kerosene-like product, and present in the straight run kerosene?

A. Yes.

Q. You also said, a little later in your examination, that heptadecane is a "typical kerosene hydrocarbon." What did you mean by typical?

A. Where is that?

Q. That is in Vol. 3 of the typewritten record, page 303.

A. Meaning that it is one of the same type as is present in kerosene, and, in fact, it would be expected to be present in such kerosene as is made from Pennsylvania petroleum, by straight distillation.

Q. Would tetradecane, itself, be a satisfactory kerosene?

A. Yes, I believe it would. It would have the reasonable flash point, it would have the approximate viscosity, it would have a rather light—that is, its viscosity would not work as well in the wick, but it would be a reasonably good kerosene, though, of course, it would be fearfully expensive to be used as a kerosene, as a commercial product. It would be only a quibbel in speaking of it as a kerosene.

Q. Would heptadecane, itself, be a satisfactory kerosene?

A. I think so. It would be not quite so—it would be a little heavier oil, and probably work a little bit better in the wick, and it would be one that would burn without—well, I think it would, for example, meet the conditions fairly well, as a kerosene for the United States Navy.

Q. Do you know what the melting points are, of heptadecane and tetradecane?

A. I slipped on that point. They are solids, at ordinary [fol. 364] temperatures, and unless mixed, would not be in a liquid form. If they are mixed—when we mix one with the other, each one would lower the melting point of the other, so that a mixture of several of these products would give a liquid.

Q. If the melting point of tetradecane is 42 degrees Fahrenheit, and that of heptadecane is 72½ degrees Fahrenheit—

A. I presume that is correct, if you say so. I know they are solids.

Q. What would be the melting point of the two?

A. The mixture would probably melt at about the freezing point of water—that is, you would lower the melting point of the lowest melting products—if you mixed them, say about half and half.

Q. That is, the melting point would be lower than the melting point of either of the constituents?

A. Yes.

Q. Is that a thing that applies to all hydrocarbons, or mixtures of hydrocarbons?

A. If they are fairly close together. That is, you couldn't mix per cent of tetradecane and 98 per cent of heptadecane, and get such a degree of lowering as I have stated, but if you mixed them something like half and half, or with reasonable nearness, the mixture would melt lower than either of the constituents.

Q. Suppose that you mix 120 melting point pure paraffin, with an equal quantity of 130 melting point pure paraffin, about what would be the melting point of the mixture?

A. There it would be intermediate between the two, because the materials you are starting with are not pure chemical compounds. They are mixtures, and, as such, this lowering effect has already taken place to a proper extent —or to a considerable extent. Probably, if you mixed equal quantities of them, it would be pretty nearly intermediate the average melting point.

Q. Now, you have given me the approximate melting point of equal quantities of tetradecane and heptadecane—that mixture, in itself, would not be a kerosene, would it?

A. It would, within the United States Navy requirements, I think, though, of course, they would object to it from the fact that it would freeze at about the freezing point of water. That would be the trouble with it, and it could not be used in northern latitudes. If they were taking a trip to Cuba I don't know that they would ever notice such a mixture, and could use it as kerosene.

[fol. 365] Q. You could not light such a mixture, could you?

A. If you tried to put it through a wick—I think you could light such mixture through a wick.

Q. With a match?

A. No, you can't light any kerosene normally, with a match. If you will take kerosene, here, in a vessel, and light a match and put it to it you would put out the match.

Q. But if I put kerosene up through a wick I could light it with a match, could I?

A. Yes, if you suck it up through a wick, but you can't light kerosene in a vessel.

Q. Would this mixture of heptadecane and tetradecane go through a wick?

A. Yes.

Q. And would you expect to be able to light it with a match?

A. I think I could. I have never tried it. That is a sort of an experiment that I haven't tried.

Q. Do heptadecane and tetradecane occur in kerosene?

A. I think so. The statement on that would be found on Day's Handbook of Petroleum Industry.

Q. And is that statement correct?

A. I don't know—I never tried it out.

Q. There is certainly something else in kerosene besides heptadecane and tetradecane, is there not?

A. Oh, yes. Those are only two of the constituents of it, but we are not, in the case of kerosene, primarily interested in getting out those constituents. We are simply, as I have understood it, discussing stunt experiments, at present—nothing that has anything to do with the question of commercial phases of the art.

Q. I cannot quite agree with that, but, rather, it seems to me we are discussing the art, whether these things that you have said, have anything to do with the practical development of the art.

Now, let us go a little further with that. Referring, again, to the tabulation on page 337 of the printed record—do you actually know that what is represented by those tables, ever has occurred?

A. I have never tried to carry those out by getting out pure materials and cracking them, and, in fact, if you will read, here, you will see that this is given simply as an illus- [fol. 366] tration of the process of cracking, not as one which was carried out as a commercial cracking process. In fact, no mention is made as to the conditions under which such cracking would take place—whether with pressure, with aluminum chloride——

The Master: You have given the range of temperatures and pressures known to the art. Are those exact formulae,

likely to occur between the ranges of temperatures and pressures given?

The Witness: Absolutely yes. There is no question about that.

Q. From your theoretical knowledge, do you also know that many various substances might result from these same starting materials and the cracking of them, other than the particular substances which you have here indicated?

A. That is true, but I have indicated, as you will note, an illustration of how unsaturated and saturated smaller sized molecules—that is, molecules of useful size for gasoline—can be made by normal cracking processes, from the higher boiling constituents, gas oil and crude oil.

Q. And do you know what there is, or would have to be in the conditions or manipulations or what not, in order to bring about, as a result, some one of these end substances as distinguished from some other possible end substances?

A. I am not at all certain that I understand the meaning of your question.

Q. What I am trying to get at is, what is it that would determine whether one or another of the products, which you say are numerous that could be obtained from these starting substances, is obtained?

A. Heat is the primary decomposing agent, and degree of heat would determine to a considerable extent; time would be another factor. Those are the two primary factors concerned. There are minor factors such as the presence of catalysts and so on, but heat and time are the essentially important factors. By "heat" I refer particularly to temperature.

Q. How would you actually go about it to produce the particular splitting up of the molecule that you have illustrated on page 337 so as to be sure to get that splitting up instead of some other possible splitting up of the molecule?

A. I do not believe that you can, with this or any other decomposition re-action in chemistry, normally expect to get cracking in only one direction. Decomposition by heat [fol. 367] of chemical compounds ordinarily produces a mixture of products, one group may be the dominant one and another minor one, but this is simply an illustration, as I have said here on the previous page:

"If we take any kind of an organic compound and heat it up, it will decompose. Some will decompose at one temperature, others at higher temperatures. If we take such compounds as are present in crude petroleum, particularly the heavier oil, and I mean by 'heavier oil', those that are heavier in gravity, and which are also higher boiling, and heat them, we will decompose them into other products."

So that this is simply an illustration of that. It is not an attempt to take a pure compound and to make a product which could be commercially sold as gasoline from it, but to show what the type of re-action was which takes place in cracking, and as I called attention, the lower portion we get—

The Master: Well, take as your starting point ordinary gas oil and hold your temperature constant at a given degree and your pressure constant at a given degree will you get all of those at the same equation?

The Witness: Largely so, but not quite entirely. There will always be variations. In the first place we cannot hold our temperatures exactly the same; we cannot, perhaps, get two samples of gas oil that will be exactly the same. And, similarly, the one time the retort may have in it carbon, or the still may have some carbon, and the presence of carbon seems to speed up a cracking process.

The Master: I am assuming that you are using a gas oil from always the same source?

The Witness: I would say that the products would be identical within the ordinary methods of analysis.

Mr. Neave: Was that all?

The Master: That was all.

Q. Now, I understand the tabulation on page 337 of the printed record to be given for the purposes which you stated. I am using it as a convenient means of expressing, or the basis for the expression of, some questions that I have in mind.

Now, I understand that tabulation to mean, first, that if you take tetradecane, you may obtain from it octane and hexylene, and again, under your equasion, B, you may start with tetradecane and obtain octane and butylene, carbon, hydrogen.

Now, my question is, what is it that you would add to [fol. 368] tetradecane so as to get the octane and hexylene in dominant proportions, as distinguished from what you would do to tetradecane to get the octane, butylene, carbon and hydrogen in dominant proportions?

A. If we use the higher temperatures we would get the octane, butylene, carbon and hydrogen reaction in greater proportion. If we carry it out in the presence of suspended carbon, coke, we would also probably get somewhat larger amounts of carbon deposit; that is, that would have the effect of higher temperature, or as we say, the carbon would, to some extent, catalyze the re-action of decomposition. Those would be the two conditions. I am not of the opinion that we can probably crack here and get only the two octane and hexylene without any of the other. I am saying that in spite of the prior art quotation which I read, in which from one kind of compound they did succeed in splitting it almost one hundred per cent, by cracking processes, into two others, but in that case one of the groups was a ring group, which is more stable group, and which was more like equation, C. Equation C has a methyl-hexymethylene. On heating it can be broken up in toluene and hydrogen with practically no by-products. That type of cracking takes place easier than (I mean by "easier" more completely), with less by-products than does that indicated by the work on the upper part of that same page.

Q. These tabulations on page 337 of the printed record show, as I understand it, a theoretically possible substance produced by breaking up tetradecane, and they do not purport, do they, to show what you know actually to have been accomplished in splitting up tetradecane?

A. I think we can say that we know that this actually has been accomplished, because we have taken kerosene and cracked it and gotten such unsaturated products; and, at the same time, certain amounts of saturated products, and as we get from our kerosene, containing such products as tetradecane and heptadecane and these other products, we can presume that they were made from them. You put in your tetradecane and your heptadecane and we get out the other, and the presumption is that the second products are made from the first; that is, a commercial cracking of kerosent products.

Q. In the practical operation of pressure stills operating on oil, do you know that anything of this sort illustrated on page 337 ever happens?

[fol. 369] A. From my general knowledge, yes; from my personal experience, no.

The Master: You have heard of many things that might occur, of which no special note or memorial was made, is that true?

The Witness: That is true. I think I do recall hearing Burton speak in a discussion of the cracking of kerosene under rather heavy pressure to get gasoline, and while he did not name hexylene he did the materials that he started with, and the fact that he got a cracked gasoline would mean that he would get such products as hexylene and octane. This was made in his discussion of the development of the cracking industry in his Perkin medal address.

Q. Am I correct in understanding from your direct testimony that there are three generally recognized tests for distinguishing between saturated and unsaturated hydrocarbons, namely, the sulphuric acid absorption test, the bromine number and the iodine number?

A. That is correct.

Q. Why do we have these three tests? Does one tell you something different from what is told by the other, or is each peculiarly applicable to some different hydrocarbon?

A. The sulphuric acid test is the easiest test to apply, but it has the disadvantage that it is not as exact in its results. Its results obtained are in general low; they are lower than the facts. In other words, it is a test which ordinarily gives a percentage of saturated products, the result of which is lower than the facts.

The bromine number, or the iodine number determinations are much more laborious propositions to carry out, though they are more exact. Each have their handicaps in carrying them out.

The time and effort taken for determining a bromine number or iodine number will probably be ten to twenty times as long as for determining the absorption by sulphuric acid. I may add, that there are still other methods besides these three, but these three are common methods.

Q. Am I right in understanding from your testimony that the unsaturated hydrocarbons are absorbed in 93 per

cent sulphuric acid at room temperature in the sulphuric acid test?

A. Yes.

Q. Am I also right in understanding that in the ordinary [fol. 370] iodine or bromine test methods, there are added to the molecule, two atoms of iodine or bromine for each double bond?

A. Normally so.

Q. What do you mean by "normally"?

A. In a few cases, particularly with compounds we know as tertiary compounds; that is, compounds of branch chains; compounds which are rarely found in petroleum, we have that bromine will react with a tertiary hydrogen atom, but those compounds are rarely found in petroleum. Similarly, we have a few compounds having double bonds, which will not re-act with bromine. Those are particularly compounds of organic acid character. Again, we have a few compounds, particularly of certain ring structure compounds, in which there is a substitution which takes place readily, as well as addition of double bonds. So that the method has to be used with some understanding. Ordinarily, there is no difficulty, though, in handling it as a method when working, say, with petroleum hydrocarbons.

Q. Those compounds of organic acid character, to which you have referred, do not occur in petroleum hydrocarbons, do they?

A. They do not.

Q. Am I also right in understanding from your testimony that the bromine number may be calculated from the iodine number and vice versa?

A. Yes.

Q. And also that either may be calculated from the number of double bonds present and the average number of carbon atoms in the molecule?

A. You will want a little more than that. You will want the specific gravity of your product and some other factors, but if you add these other factors, yes.

Q. Can a sulphuric acid absorption value be likewise calculated if you know the iodine or bromine number and the average number of carbon atoms per molecule in a given mixture?

A. No. You can get it approximately but not at all accurately. For example, diolefines are, in part, resinified, and changed to resinous materials and are not absorbed by the sulphuric acid, so that the sulphuric acid number is low by the extent to which those products are not absorbed by the sulphuric, though they are acted upon by the sulphuric acid.

The bromine number would not be subject to this same limitation. The bromine number, in other words, is a [fol. 371] more accurate determination in general than the sulphuric acid method for unsaturatedness of the material.

Q. In the gasolines in which the diolefines are not present, you do not meet the difficulty that you referred to in the first part of your last answer, do you?

A. No, you would not.

Q. You have indicated, have you not, that the two main —I beg your pardon.

A. May I add one other phase?

Q. Yes.

A. We should also have the absence of nitrogen compounds and some sulphur compounds. They also throw off your sulphuric acid determination.

Q. You have shown, have you not, that the two main classes of unsaturated hydrocarbons are the olefinic hydrocarbons and the aromatic ring hydrocarbons, such as benzol?

A. Yes.

Q. And the members of both of these classes of compounds respond to the three tests for unsaturated compounds, do they not?

A. Not with the same degree. The aromatic and ring compounds do not absorb in sulphuric acid of 93 per cent as readily, but we were primarily concerned, when I was discussing here, I presume, with the ordinary products which are formed in the cracking process, such as from Pennsylvania petroleum, and there are practically no ring compounds present there—a very small percentage. If we go to the two which do carry ring compounds, the Russian and the California, we should change our sulphuric acid test to use a stronger sulphuric acid than 93 per cent.

Q. But the iodine and bromine tests are applicable to those classes of unsaturated hydrocarbons; that is, both

the olefinic hydrocarbons and the aromatic ring hydrocarbons such as benzol?

A. In general, with the limitations which are earlier expressed on these bromine and iodine numbers.

Q. Is it not true that the aromatic ring compounds have a large number of characteristic reactions and properties which form the basis of several industries, such as dye stuffs, synthetic perfume, high explosives and so forth, and which are radically different from those characteristic of the olefinic group of hydrocarbons?

A. Yes.

Q. Just what would be the iodine number of a mixture [fol. 372] of five parts of straight run, 70 degree Baume petroleum naphtha, and one part of commercial, 90 per cent benzol, assuming that the naphtha had an iodine number of three to start with?

A. Do you know what the other 10 per cent of the benzol is?

Q. Assume it is toluene.

A. It would have an iodine number of about 14.

Q. What would be the amount of absorption by benzol, 93 per cent sulphuric acid from such a mixture, assuming that the naphtha itself showed an absorption of 5 per cent?

A. 5 per cent?

Q. Yes.

A. Did I understand a 5 per cent?

Q. Yes.

A. And yet with an iodine number of only three. We will take your figure there, which is perhaps a little surprising. It would be a sulphuric acid absorption of approximately 4, it being recalled that I spoke of the benzol as a product which was not absorbed by 93 per cent, but which we must use stronger sulphuric acid for, if we are going to use the sulphuric acid method for a product carrying benzol.

Q. You described how you proceeded to determine the bromine number of a given hydrocarbon. Am I right in assuming that this method which you have described is one of the standard methods?

A. Yes.

Q. Which method was it? Has it a name?

A. It was first worked out by Allen, the highest ranking analyst of England. I do not know whether it has a special name or not.

Q. And that Allen method is described in one of the publications in evidence here, is it not?

A. I do not think so.

Q. Then where it is found?

A. It possibly may be, but you will find it described in Allen's "Commercial Organic Analysis" on other pages, some of which were cited here. I do not recall that the method itself was described here.

Q. Will you look at pages 4, 5 and 6 of the publication that is in evidence, entitled, "Hydrocarbons" by F. C. Garett, which is taken from Allen's "Commercial Organic Analysis" and see if that describes the method of analysis to which you refer?

[fol. 373] A. This is the method to which I referred; the earlier method was a method using water as a solvent instead of carbon bisulphide.

Q. And this method to which you refer is the method described by Garett, is it not?

A. Yes, but I think you will find that the first publication of this was not in this book, but in an article by Allen in one of the journals, and that this is a chapter in which Garett is quoting Allen's method.

Q. What is the standard method for determining iodine number; has it any well recognized name?

A. There are two of them, Hubl and Wijs' are the two methods.

Q. The Hubl method is the only one that uses iodine alone, is it not?

A. The Wijs' method is the one which uses iodine and chlorine, but it gives the iodine number and is more commonly used than the iodine alone.

Q. Hubl uses the iodine alone?

A. I think so, but I am not certain about that. The iodine-chlorine is the one that is normally used.

Q. When you use the Wijs' method, you merely calculate the iodine number, don't you? You do not get it directly as you do in the Hubl method?

A. In the Hubl method you do not get it directly; you measure it in the amounts of sodium-thiosulphate and then

you calculate it, so that you calculate it from the sodium-thiosulphate, and in the other you calculate it with the sodium thiosulphate but you do have present in your Wij method chlorine as well as iodine, and in the other I think you have only iodine, though I am not certain.

Q. And Chlorine is one that acts on double bonds?

A. I imagine so.

Q. Have you ever performed a sulphuric acid absorption test on aromatic hydrocarbons or mixtures thereof with petroleum hydrocarbons?

A. Yes.

Q. Have you ever, yourself, submitted a given sample of a petroleum distillate to the sulphuric acid test, to the bromine test and the iodine test to see whether the calculation of one from the other was actually in accordance with what you have said, that is, to see that the iodine number was always 1.6 more than the bromine number?

A. No, I do not recall that I ever submitted it on such a [fol. 374] sample as you suggest. I have on other organic compounds, though.

Q. In my question I used the words that you did in your testimony, that is 1.6 more. Is that right or should it be 1.6 times?

A. Times.

Q. What were the character of those other organic compounds?

A. Organic oils particularly, as I recall; that is, not petroleum products.

Q. Were they hydrocarbon oils?

A. No, they were esters of the fatty type.

Q. Then you base your testimony with reference to the iodine and bromine numbers on your knowledge of what you conceive to be the recognized chemical facts with regard to hydrocarbon oils and their re-action to iodine and bromine?

A. I was giving the general facts regarding bromine and iodine numbers, as determined by the ordinary methods for chemical compounds in general, and I believe that hydrocarbons of the ordinary type, such as straight chain hydrocarbons primarily fall within this class, within the error of measurement.

The Master: Are these ratios generally accepted by chemists?

The Witness: Yes, We get into some trouble with them when we get to handling these aromatic compounds—such compounds in American oils—are present say on an average of a tenth to three-tenths of one per cent. But generally speaking, they are accurate.

Q. What is the iodine number of pure benzol?

A. I do not think I have ever made any determination. I do not know as I have ever seen one made, but its bromine number is about 36.

Q. And you would calculate your iodine number from the bromine number?

A. You could calculate your iodine number from that.

Q. Using this 1.6?

A. Using this 1.6, but you will have in there the class in which your iodine re-acts with least readiness, and remember that benzol, in our cracked gasoline, is present in very small quantities, perhaps—oh, less than two per cent; less, probably than a half of one per cent. I am speaking of American rather than Russian products, or California oils. [fol. 375] Q. In speaking of the amount of benzol in these oils, do you mean the pure benzol or the aromatics?

A. Well, I was thinking of the pure benzol present, though there are smaller amounts in general of other of the aromatics, such as toluol.

Q. Does it take long to go through the bromine test or the iodine test on a sample?

A. Yes, fairly so. That is, if you have to make up your solutions. If you start fresh, for example, I would say that it would be a whole day's task; whereas, with the sulphuric acid test there, it would be probably six minutes. If you had your solutions made up it would be a much less task, a task perhaps of an hour.

Q. Would you be willing, yourself, to perform such experiments as may be necessary to enable you to determine whether benzol responds to the recognized bromine and iodine tests?

A. I presume so. We have here, in one of the articles which you quoted, a bromine number given as 36. I scarcely see that it is worth while to carry it out.

Q. I have begun to feel, doctor, that these statements we find in the books have got to be verified.

A. Possibly it is in error, I would be glad to carry it out if you desire.

The Master: If they have been published for quite awhile, it would be strange they would not be contradicted.

Mr. Neave: The results I have are exactly contrary to what the doctor has given. I think he ought to have an opportunity of seeing that his testimony regarding the iodine number and bromine number is right. If he is willing to do it on Saturday, I will be glad to have him do so.

The Witness: I have got one engagement Saturday which will take me all day. I am willing to do it tomorrow or I am willing to do it Monday.

[fol. 376] Mr. Neave: I suggest, doctor, that in those tests you use a ninety per cent commercial benzol.

The Witness: Rather than a pure benzol?

Mr. Neave: Use a pure benzol if you want to, I thought the other would be easier for you to get.

The Witness: I have got both of them in my laboratory.

Mr. Neave: Use pure benzol.

The Witness: Either one of them?

Mr. Neave: Yes.

The Witness: The one that I refer to, where it is given as a value of 36, is an article by Allen where he is comparing the commercial products. I think it is in the Analyst.

The Master: Is there some possibility that these tests made a number of years ago might have been with iodine and bromine of perhaps purer or less pure nature?

Mr. Neave: It may be, I do not know.

The Witness: I find in this, your Honor, that he has used for this a slightly different condition. This would be made in 1881, and the other one is of 1910, so that the two methods described there by Allen are different.

The Master: What is the later one?

The Witness: The later one is the carbon bisulphate method, and he does not give the benzol factor. The other one is the sodium hypobromide method, and gives the factor of 36.2 bromine number of pure benzol.

The Master: Now, taking 36.2 and 37—was not that the other number?

The Witness: Yes.

The Master: Does your experiment differ wider than that?

Mr. Neave: Wider than what?

The Master: Wider than the difference between 37 and 36.2.

Mr. Neave: Differs much more than that.

The Master: I said that because the witness says that in 1910 Allen, by some process, cracked his number to 36.2.

Mr. Neave: Yes.

Q. Do you know the number of double bonds in benzol?

A. In the Kekule formula for benzol, they are given as 3. This is not, however universally accepted. There are some people who say that there are no true double bonds in benzol formula; for example. Bayer gives a formula which is free from any evidence of double bond properties.

[fol. 377] Q. In your direct testimony you have cited three double bonds in benzol?

A. Yes, by the Kekule formula.

Q. And from that you can calculate the bromine number, can you not?

A. If it re-acted with bromine in the same sense that the olefines do.

Q. And I understood it was your view that they did re-act in the same way as the olefines?

A. No, I raised a question, in part, regarding that. I said the aromatics did not re-act as readily with iodine, for example, or with iodine chlorine, as the ordinary olefines which are present in cracked gasoline.

Q. How about the bromine?

A. (continued). And at the same time, I called attention that the aromatics, such as benzol, were present in present-day gasoline in insignificant quantities, so that the question as to whether they did or did not re-act was of no importance in your measurement. It was essentially within what might be spoken of as the error of sample or the error of measurement.

Q. As I understood your last answer, you were talking about the iodine number all the time; I was speaking of the bromine number. Is there any difficulty in calculating the bromine number?

A. Yes, there would be. Some of the aromatic compounds will re-act much easier than others, and while the

bromine number determined in one method, for example, as Allen may give us 36, determined in another method, particularly if not enough time is allowed for it to re-act, it will be undoubtedly lower.

Q. The time of the re-action is specified in the method, is it not?

A. I imagine so.

Q. And you would propose to carry out this test—I beg your pardon.

A. (continued). The method is primarily not for aromatics, but it is primarily for olefines of the straight chain type, not of the ring compound type of aromatics, and while Allen gives his per cent and gives a factor for benzol for bromine in this 1881 publication between 36 and 37, the general knowledge is that bromine does not re-act on your more stable ones of these as readily as it does on the [fol. 378] olefines. With most of the olefines, the re-action is practically complete in three minutes.

Q. In the test that you are going to make you will use the pure benzol and you will determine the bromine number by the Allen method?

A. By what?

Q. By the Allen method or the method described by Garrett in his article given by Allen, and you will determine the iodine number by what method, the Hubl or the Wijs?

A. I would use the Wijs.

Q. Use the Wijs?

A. Yes. I might as well use both of them, perhaps.

Q. I would be very glad if you would use the Hubl also. If it is not too much trouble I would be very glad, in addition to your running those tests on the benzol, you would also run them on a mixture of benzol and 70 degree naphtha; that is, five parts of the 70 degree naphtha and one part of the benzol.

A. I haven't the slightest idea where I can get hold of some seventy degree naphtha.

The Master: Perhaps it would be well for you to submit a sample.

Mr. Neave: I would be very glad to if he will take it.

The Witness: I will.

Mr. Neave: All right, I will have it for you tomorrow, then. Doctor, how much would you like of that 70 degree naphtha?

The Witness: Oh, a pint is plenty.

Q. How does the carbon hydrogen ratio of shale oil compare with that of well petroleum? I am not asking you to give those in figures, but which is the larger?

A. I think that we would find that ordinarily the shale oil petroleum would have a somewhat larger carbon hydrogen ratio, that is, larger percentage of carbon than ordinary petroleum, but that we would have some petroleums which would have as high a percentage of carbon in them——

The Master: Carbon hydrogen, you mean.

The Witness: No, the carbon hydrogen ratio. As high percentage of carbon in them as some shale oils; that is, that ordinary shale oils would be perhaps intermediate in carbon hydrogen ratio between the extremes of petroleum, though larger than most petroleums.

Q. Larger than the Mid-Continent or Pennsylvania petroleums?

A. Yes.

[fol. 379] Q. How does the carbon hydrogen ratio with cracked gasoline from shale oil, compare with cracked gasoline from Pennsylvania or Mid-Continent petroleum?

A. I presume you mean that with the carbon hydrogen ratio, cracked gasoline from Pennsylvania or Mid-Continent oil?

Q. Yes.

A. I would say that they were essentially identical, though I do not recall any exact determinations that have ever been made of the two in comparison for equal boiling ranges.

Q. Then, what becomes of the excess carbon in the shale oil when it is cracked?

A. The same as when using a heavy petroleum, not a Pennsylvania or a Mid-Continent, we leave behind considerable amounts of coke.

Q. Am I right in my recollection that you said that in the bromine test, there were added two atoms of bromine for each double bond?

A. Yes, in the olefines.

Q. And that is not the rule with the benzols?

A. I said that it was not the rule with tertiary branch hydrocarbons, and that it fell down in some cases of double

bonds, particularly those having acid groups, and that it did not act or did not give that with all aromatic compounds; that is, there are limitations to the addition.

Q. So you cannot make that calculation as to benzol; you cannot calculate the bromine number on pure benzol?

A. I was of the opinion that Allen was right until you quoted a moment ago, or raised the question on it, and it is possible that he is incorrect, as I notice now these schemes were determined by two different schemes, one using a sodium hypo-bromide scheme, and one using the later carbon bisulphide scheme, and as I think over it I recall certain aromatic compounds which are not readily affected by a bromine, none of which, however, would I expect to be in ordinary cracked gasoline.

Q. On the assumption that two atoms of bromine are added to each double bond, can you calculate the bromine number of benzol?

A. On that assumption, plus the assumption that benzol has the Kukule formula with which it is commonly written, we can calculate the bromine number.

Q. What would be the bromine number in accordance with that calculation?

[fol. 380] A. I will try and calculate it. It would be quite large, 165. Apparently, Allen, in his earlier work there was forming a compound subject to what we speak of as stearic inference; that is, unless you get a bromine atom in there, it stops further action on that.

It is perhaps not for me to explain why he got the results that he did, in which he says that 100 grams of benzol will combine with 36.2 grams of bromine; that is, that benzol would have a bromine number of 36.2.

Q. You have stated in one of your answers on page 338 of the printed record that "In some of the American petroleums we do find some ring compounds." What are the ring compounds to which you are here referring?

A. What page?

Q. Page 338 of the printed record, the second answer on that page?

A. The ring compounds present are more of the type as given on page 337, the hexymethylene compounds, that is, compounds which would give such as toluol by cracking processes. There may be present some benzol and toluol in the product naturally, but I think there is small evidence

as to its existence in there in any considerable percentage. I recall that in one plant in California in the war-time, they ran it through the cracking process to get, as I understand, a total of a three per cent yield of toluol, and that was all they could get out of it, even after they had cracked it, as well as taking what was in the oil.

Q. Am I right in understanding from your last answer that most of the ring compounds present in American petroleums are the naphthenes?

A. I do not know as it is entirely proven but that is the general understanding.

Q. What is your authority for saying that there are only comparatively few of these ring compounds in American petroleums?

A. Because we get out from our crude petroleums—we fail to get out any considerable amount of those ring compounds. We would like to get them if we could. In the war-time, for example, toluol was worth seven dollars and a half a gallon, and if we could have gotten a yield of even a few per cent we would have been delighted to have done so, rather than to sell the product as gas oil or as kerosene at, say, six or eight, ten cents a gallon instead of $7.50 a gallon.

[fol. 381] Q. Is toluol a naphthene?

A. No. I say, if there were ring compounds and if there were naphthenes, such as methyl-hexmethylene, which is a naphthene, in any considerable quantities, we would have cracked it and obtained our toluol from it in real production. I do not count that a plant that will only give a 3 per cent yield and have 97 per cent of by-products as an indication that they are present in any large amounts.

Q. Now, is this that you have cited the only reason for making you consider and say that they are only comparatively few ring compounds in American petroleum?

A. No, I have discussed it with one of the men whom I think perhaps best posted in that field in the country, Mr. Fulwilder, of the United Gas & Improvement Association, and he says——

Q. I do not think we ought to have this discussion with somebody else.

A. You asked me what my reasons were, and here is a man who is running plants which depend upon this factor, and though they have spent thousands of dollars, have actually failed to prove the presence of naphthenes in many

of the distillates furnished them as gas oils. I would consider Mr. Fulwilder probably as high an authority on naphthene chemistry as we have in this country.

Q. This gentleman that you referred to is a user of gas oil, is he not, rather than a person who starts with crude oil?

A. That is true but they are interested as to the presence or absence of naphthenes in the gas oil, and they are probably the largest users of gas oil; their specifications being perhaps those which are of most importance to any seller of gas oil.

Q. Does the Pennsylvania crude oil itself show any appreciable iodine or bromine number or sulphuric acid absorption?

A. I thought I had data here but I do not find it. I do not know; I have never made a test of Pennsylvania crude oil.

Q. If it showed no iodine or bromine number or sulphuric acid absorption, it would mean that it was composed of saturated hydrocarbons?

A. In general, yes.

Q. And you do not know that it is composed entirely of saturated hydrocarbons?

[fol. 382] A. I do not think that we can say that it has 100 per cent of saturated hydrocarbons. It has a small amount of sulphur in it; it has products which, on its distillation, give coke; it has other evidences which would make us expect that it would have some other things in it than simply straight paraffin saturated hydrocarbons.

Q. Would you say that it was composed almost entirely of saturated hydrocarbons?

A. Yes, I would say that, almost entirely.

Q. Then it would not have any appreciable iodine or bromine number or sulphuric absorption, would it?

A. Well, I think that it is lower, but as I understand it, it does have an appreciable amount of unsaturated products present, though it is almost entirely saturated.

Q. Then the Pennsylvania crude oil is composed almost entirely of paraffin hydrocarbons?

A. I would say that the lighter constituents are almost entirely of paraffin hydrocarbons. I do not believe it has been proven whether the heavier constituents are almost entirely of paraffin hydrocarbons, or whether they may not carry some naphthenes. The naphthenes re-act as satur-

ated hydrocarbons but I think the percentage is small. I should say in general, though I have not tested it, that Pennsylvania oil would run 85 per cent or more of saturated product.

Q. And those are paraffins?

A. Almost all, not all.

Q. And are they of straight chain hydrocarbons?

A. In general, yes.

Q. You mean they are mostly, by "in general"?

A. Mostly, yes; nearly all of them, of the individual components that go to make it up.

Q. About what percentage of these straight chain hydrocarbons are there in the Pennsylvania crude oil?

A. I do not know from personal knowledge, nor do I recall ever having seen a determination; in fact, I doubt if our present knowledge would permit a determination from a sample of oil, as to what percentage of naphthenes and of straight chain hydrocarbons it would have within an error of say 25 per cent, of the naphthenes that were present.

I know, for example, of laboratories which have purchased instruments for that purpose and paid as high as $2,000 for them and then had to put them into the discard because they failed to be able to use them successfully.

[fol. 383] Q. I thought you said a moment ago that there were practically no naphthenes in this Pennsylvania crude oil?

A. No, I said we could not determine, but the general belief is that there are none, or almost none; but the method of determining is only one of inference and is not at all an exact one.

Q. When you said, on page 338 of the printed record, "that in some of the American petroleum we do find some ring compounds, but only comparatively few," were you intending to include in that the Pennsylvania crude oils?

A. Yes. That is, in Pennsylvania oil my own belief is that we have no definite proof that there are any, say to the extent of one or two per cent. There are people who have stated that there are as much as twenty per cent or possibly more, but I do not think that they have really proved their case.

Q. But upon your belief and testimony there are comparatively few of the ring compounds in the Pennsylvania crude oil, and therefore it must be, must it not, that most of

it is made up of the paraffins-of straight chain saturated hydrocarbons?

A. That is my belief and is the common belief.

Q. Pennsylvania crude characteristically gives a large yield of good quality, high boiling lubricating oils, does it not?

A. Most lubricating oils I know are sold as if they were, and are spoke of as Pennsylvania lubricating oils, but I know also that a considerable amount of it is Pennsylvania lubricating oil only in that it has been through a Pennsylvania refinery, though made from Mid-Continent or Ohio oils, and is Pennsylvania only in that sense. It is a trade term, like "Virginia Ham."

A. Not particularly. We have practically the same thing in amounts of oil and the oils are apparently of the same gravity when made from the Mid-Continent and even from some of the more distant oil fields. The yields are, in some cases, even larger.

Q. What is the yield of lubricants from Pennsylvania crude oil?

A. I have some work carried out under my direction; it is in comparing these typical oils from various sections, as [fol. 384] there had been no work such as that carried out and published that I could find. This was carried out, beginning a year and a half ago, and finished last April; and the total, if you will start say with 100 viscosity oil, 200 viscosity oil and the steam refined cylinder stock residuum, the sum of the three, these all being subject to the same methods of purification, and apparently gave the same quality of oil.

The Pennsylvania oil gave a total of twenty-five and a fraction per cent; the Burbank oil gave twenty-five and a half per cent, total, the Texas oil, from the Pioneer Field, gave 19.7 per cent, and oil from the Gulf Coast Field gave 34.7 per cent. So that we would have the Pennsylvania oil, as, perhaps, an intermediate oil. The oils were all treated by the same method of distillation and refining, in order to get comparisons as to amounts, and as to qualities, and gave approximately the same quality and the amounts as I show—the Pennsylvania oil being intermediate in amount.

Q. What did you get from the Mid-Continent oil?

A. Twenty-five and a half, and from the Pennsylvania, twenty-five and one-tenth, and from the Pioneer Field, Texas, 19.7; and the Gulf Coast, 34.7 per cent.

Q. Is the yield of high boiling point lubricant oils from Pennsylvania petroleum, several times the yield of wax from that petroleum?

A. I don't know as I have recorded here the amount of wax obtained from each of these. Some of them gave almost no wax. I don't find that I have the figures for wax.

Q. Don't you know that there is not twenty-five per cent of wax in the Pennsylvania crude?

A. Well, but you were speaking of the high boiling portion, which I was referring to here as the part just before the steam cylinder stock, as I understood, and that only had 2.7 per cent of wax,—no, 2.7 per cent of oil.

Q. What was that 25 per cent figure you gave me?

A. I read it to you as the sum of the three types of lubricating stock.

Q. That is all right.

A. But under viscosity—the 200 viscosity oil preceding the cylinder stock, as I understood your second question following that, was as to the amount of wax, compared with the amount of high boiling viscosity—or high viscosity oil—which would be only 2.7 per cent.

Q. I see we have misunderstood each other. In that oil [fol. 385] which had the twenty-five per cent, as you said, of lubricating oil, how much wax was there?

A. There is no figure here, and I don't recall the amount.

Q. You know that there would be several times as much of the lubricating oils as there would be of the wax, don't you?

A. I would expect so.

Q. Now, if that lubricating oil is, as you seem to have said, composed almost entirely of straight chain paraffin hydrocarbons, how do you account for the fact that it is not a wax, with a melting point well above 100 degrees Fahrenheit?

A. This is one of the customary arguments for the presence of naphthenes, but it is not a necessary sequence from that.

If we had, here, for example, the presence—or, I will put it this way—the presence of a considerable number of con-

secutive hydrocarbons of the paraffin group, we would expect lower melting than if we had the same amount of one constituent—say a medium constituent, so far as the number of carbon atoms in the molecule is concerned, as we had before, and it is quite possible that our lower melting phase here—and that the non-crystaline character is due to a mixture rather than to the presence of naphthenes.

In other words, if we had here fifty or sixty per cent of one constituent, it would crystalize whereas if we had a number of constituents we would have the same things as we mentioned in our case of our tetradecane and heptadecane—each one affecting the melting point of the other.

Q. Doctor, what is the lower limit of temperature for appreciable cracking? Of course I am referring to petroleum oil.

A. It depends somewhat upon the oil, but we can have appreciable cracking with these hydrocarbon oils at temperatures as low as 350 degrees Fahrenheit.

Q. You are speaking now of well petroleums?

A. I am speaking largely from my knowledge of shale oil petroleum, and I think that well petroleum will come within the same range.

Q. What is it that occurs in well petroleum at a temperature of about 350; what kind of cracking?

A. Cracking to form products having lower molecular weight.

Q. What products, for instance, would be formed at those low temperatures?

A. I do not know their chemical formulae. I do know that the vapor pressure rises if the product is kept at that temperature showing that there has been cracking taking place.

Q. How much does it rise?

A. Measurements were not made in the way of pressure measurements, numerical measurements.

Q. Then, what is your basis for the statement that the vapor pressure does rise if the product is kept at that temperature?

A. Because, when the vessel is opened, after being cooled down to the temperature at which the comparison was made, there is a pressure outward of vapors.

[fol. 386] Q. I do not quite visualize what that experiment was, Doctor; can you give it to me a little more definitely?

A. One of the experiments was carried out in a glass tube; the petroleum sealed into the glass tube and then the product heated; and after cooling down, the tube opened, and when the tube was opened, there was some increase in amount of vapor, as was shown by the fact that when it was still in the flame, the end of it, the tip of it, it puffed out when the glass was opened.

Q. And you mean to say that could be due only to the breaking down of the other molecules to form the molecules of the lighter hydrocarbons?

A. That could be due to a giving off of hydrogen as well, but that is a smaller molecule, as I indicated in my answer.

Q. Then, can you tell we what is the lower limit of any cracking of the kind that we have been talking about; that is, breaking up a hydrocarbon molecular so as to get a lighter hydrocarbon molecule of another oil, such as gasoline?

A. I think this was that, though it might possibly have been hydrogen. I would judge, again, that it was that, because the gas that came off had an odor, and hydrogen would not have an odor. Of course, some evaporated petroleum would add a little odor to it, but not as much as we apparently got.

Q. If there was any cracking that took place at that temperature, it would be a very small and uncommercial cracking, would it not?

A. Yes. In my first answer I said this was not a commercial cracking. A commercial cracking requires higher temperature.

Q. What temperature is, as a matter of fact, used for commercial cracking?

A. We have had temperatures given in the various citations ranging from around, as I recall, 500 degrees Fahrenheit on up to as high 2000 degrees Fahrenheit. To get it to go at a reasonable speed, we would expect to use temperatures in the range of 600 or 700 Fahrenheit.

Q. What temperatures are actually used, do you know?

A. Temperatures in that range are from six to seven hundred.

Q. What is it that determines the temperature at which the cracking can be commercially carried on?

A. We must have a temperature which will give a speed [fol. 387] that will permit of the process being accomp-

lished in a reasonable time; that is, will give a reasonable output per plant per day. On the other hand, the upper limit is determined essentially by several factors; one, the use of high temperature, becomes injurious to the plant and possibly dangerous if pressure is being used; the use of high temperatures tend to promote carbon formation and the coking up of the still; the use of high temperatures tend to promote more complete cracking, that is, cracking down to hydrogen and methane and other uncondensable gases which have little commercial use. So that we are between the situation of too slow a cracking, that is too low a temperature which will give an absence of profit to the plant, due to the small output; or, too high a temperature which will give these handicaps that I have mentioned, and indirectly makes the process again non-profitable; so commercially, it comes, as all commercial things do, to a question of what is profitable.

Q. I believe you said that last summer you visited a plant near Providence, Rhode Island, and saw the Burton process being carried on, or the so-called Burton process?

A. What was said to be the Burton process.

Q. What temperatures were they using there?

A. I looked at my memorandum to see if I had a record of temperatures that they gave. I did not have such a record so that I am not absolutely certain.

Q. You have no idea what temperatures were being used?

A. Oh, yes, I have an idea.

Q. What was it?

A. I imagine that they were using about 650 Fahrenheit.

Q. Could a satisfactory kerosene be made, complying with the standard specifications, by taking some of the heaviest portions, for instance, and adding to them some of the lightest portions and get within the required limits of viscosity and flash-point?

A. Heaviest portions of what, California crude?

Q. Yes.

A. No. That is, unless you took an insignificant amount of the heavy cylinder oil of California crude, or Gulf Coast crude, or such things as that. Your product would have sulphur in it and it would burn with sulphur odors, and it would give trouble from wick climbing; and if you had it say 50 per cent, you would have trouble with flash-point. I

[fol. 388] think you could say without any hesitancy that it would not meet——

Q. You have said that the boiling points do not mean very much in connection with kerosene. Do you mean by that also that a kerosene to be a satisfactory kerosene within the standard specifications does not have to have components or portions that boil at certain end points and at certain intermediate points, a certain amount being given off at different temperatures in the intermediate points?

A. Yes, roughly, but not exactly. That is, the boiling fractions, for example the point which we were speaking of primarily yesterday, was the point at which the kerosene began to boil, and that at present day is of very little importance. We do not care, within 50 degrees, where it begins to boil; we do care for a question of flash-point; we do care for a question of the burning test; we do care for sulphur content, for wick-climbing character, for illuminating character and so on; but at present day most of the commercial kerosenes could have been made at a cut distillate lower than they are made and still be kerosenes which would be satisfactory in quality. But that is not done because at the present day we want gasoline, that is, the high priced product per gallon as compared with kerosene, and this condition brings about that the starting point or the boiling distillation range of kerosene is not now of importance as it was when refiners put as much gasoline in it as possible.

The Master: You are confining your answer to the kerosene used for domestic lighting and cooking?

The Witness: Yes. That is what the large amount of it is used for, and it is that and only that which is really concerned in these specifications; kerosene that is used for——

The Master: If it was kerosene designed for some other use than that, then its boiling point would become important?

The Witness: Yes, it might be. For example, on the question of tractors, there are some tractors built to use kerosene because it is cheaper than gasoline.

The Master: The Rumley Oil Pool tractor uses kerosene.

The Witness: Yes. I did not recall that particular one, but it is used because it is a cheaper fuel primarily.

Q. But with kerosene used as an illuminant, the particular initial boiling point and the end boiling point is of no special importance?

A. They are not at the present day of major importance. [fol. 389] The major important items are such as I read from the Navy specifications.

Q. And in kerosene used as an illuminant, it does not make any difference how much would boil off at an intermediate point between the initial boiling point and the end boiling point?

A. Oh, I think it would make some difference, yes. You would get a different product if you took only the ends of it and took out the intermediate portions.

Q. Now, suppose that we take out the intermediate boiling portions in kerosene and change our end portions so as to have more heavy materials in one end and more lighter materials in the other, would you not get a product of the same viscosity and flash point that we had before?

A. How much would you use of each?

Q. I do not know.

A. You would certainly not, if you used say ninety per cent of your early part and ten per cent of your late part. It would be possible to make such a mixture that would have it, but you would have to use a good deal of acumen in mixing up such a mixture so far as that particular test is concerned.

Q. That is what I had in mind, that you could make a kerosene of the desired viscosity and flash point and so forth, come within the standard specifications?

A. Yes, but not the "and so forth."

Q. (continued). By eliminating the intermediate fractions or portions and re-adjusting the heavier and lighter portions, could you not?

A. No. You would have trouble with the "and so forth" portions that you mentioned.

Q. What is the trouble in the "and so forth"?

A. The question of wick climbing and of some of the other phases of it. I would wish to call your attention, also, that if you start with two materials, A and B, which have certain properties and you want to make a material having an intermediate viscosity, for example, of A and B, you can mix these to get an intermediate viscosity, and you can mix them also to get an intermediate flash point;

you can mix them also to get an intermediate burning point, but in general, you cannot mix them so as to get any two of them. That is, you have got two factors here, which, when we change, you may accidently strike two of them, but it is only accidently so, because they are, to a considerable extent, independent variables, and as such the [fol. 390] average will not be the same if you do that.

Q. You can arrange your heavier and your lighter portions so as to get your desired viscosity, could you not?

A. Yes.

Q. And the wick climbing, if that is the word, capability is due entirely to viscosity, is it not?

A. Primarily to viscosity.

Q. Is that not all?

A. No, it is not. For example, water and oil placed in a lamp, the oil will wet the wick more than the—perhaps I can illustrate it better with another material.

Colza oil, (not mineral Colza oil), or rape seed oil has a certain viscosity. Its wick climbing character is not the same as petroleum oil of the same viscosity.

Q. The wick climbing properties do not have to be the same in various kerosenes, do they, in order to come within the specifications, but they only have to exceed a limit?

A. In general, yes.

Q. Take two different kerosenes, both made from well petroleum oil, is there anything that determines any difference in their wick climbing properties except the difference in the viscosity between the two?

A. Possibly. I am not certain about that. I do not pretend to be an expert on wick climbing characters; I am much more interested in the modern lighting materials, and the modern lighting materials, and the modern fuels, such as cracked gasoline. This is a phase that is of relatively little importance at the present day.

Q. I am trying to visualize still the kerosene with the intermediate boiling portions left out, and keeping my mind on a heavy portion and a light portion and a readjustment of them, so as to give the desired viscosity. A very small amount of lighter portions added will very profoundly affect, will it not, the viscosity and the flash point?

A. Yes.

Q. The addition of these lighter portions would lower both the viscosity and the flash point?

A. Yes.

Q. And do so very markedly?

A. Distinctly.

Q. Do you know how the viscosity of kerosene is measured?

A. It is measured, as I understand it—I have measured [fol. 391] in times past, though it has been, I think, twenty years ago—in the ordinary type of machine for measuring viscosity, such as used for light lubricating oils and for other products. That is one way of measuring it.

Q. Is that the Saybolt instrument?

A. The Saybolt instrument at that time was not permitted to be sold by the Standard Oil Company. They sold their products on a Saybolt viscosity, but they refused to allow other people to buy the Saybolt instrument for testing them to see if they even met their own requirements, and as such it was impossible to make a Saybolt viscosity determination by anyone who was not in the employ of the Standard Oil Company.

Q. Then what did you use to measure the viscosity?

A. I think it was an Engler. It might have been one of the English types. It was, as I say, done twenty years ago and I do not recall what instrument was used at that time.

Q. What is the commercial way of measuring viscosity today, of kerosene?

A. The use of the viscosimeter.

Q. Any particular make, I mean?

A. The Saybolt and the Engler are both used, the Engler probably in more of the world than the Saybolt, but in this country, mostly Saybolt. Saybolt is now on the market due to the pressure brought by the Bureau of Mines and Bureau of Standards at Washington.

Q. Well, in the period twenty years ago to which you referred, was kerosene sold on a viscosity specification?

A. I do not know. That is, I was not testing it from the question of an illuminating oil, but I was testing it for another use.

Q. Well, twenty years ago was kerosene sold for any uses on a viscosity specification?

A. I said I did not know.

Q. I did not understand that from your last answer.

A. I said I did not know, then I explained why I did not.

Q. Then, if you do not know that it was sold on a viscosity specification, why did you bring in about the Standard Oil Company not selling the Saybolt instrument, or not permitting people to use it?

A. Because you asked me what instruments were in use and what instruments are in use, and what instruments I used.

[fol. 392] Q. Did you ever try to get a Saybolt instrument from the Standard Oil Company in those days?

A. Yes, through Eimer & Amend Company of New York.

Q. A refined oil instrument or lubricating oil instrument?

A. I do not remember now. I tried to get it through them, who are the largest dealers in testing apparatus in the country, and they replied that they had tried before and failed to get it and could not supply it.

Q. Is the instrument that is used now, the Saybolt standard universal viscosimeter?

A. That is, I think, the more common one of the Saybolt forms. There have been several of them. Each, I think, has been patented in order to control it. The Saybolt instrument is an instrument which has been heavily criticised by the Bureau of Standards on account of its arbitrariness.

Q. You have said, on your direct examination, that compression of a gas warms it, and so there is a greater difference in temperature between it and the condenser, and, accordingly, the condenser works more readily. Isn't the real effect of compression not the real heating but the raising of the temperature at which the gas will condense—that is, the gases will liquify at a higher temperature when under compression, than at atmospheric pressure.

A. Both my statement and your statement, I think, are true.

Q. If my statement is true, then, from the standpoint of condensing, it would be really better if the compression did not heat the gas, would it not?

Mr. Rauber: Pardon me, but do you mean pressure, or compression?

Mr. Neave: Compression is the word that he used—on page 465 of the typewritten record.

Mr. Rauber: That was with reference to the Hall patent?

Mr. Neave: I don't know what patent it was, and I don't care what patent it was.

A. That is what I thought. The previous three lines, or the third line above is with reference to the Hall patent, and in the Hall patent it is compressed just before it is sent to the condenser, and, as such, it is a heating of the gas just previous to condensing it. The question of compression and pressure are not equivalent terms, as you have implied.

Q. I am not asking anything about the Hall patent, and I did not know I was making any such implication as that which you have just referred to.

[fol. 393] I am talking, now, about a scientific fact which you seem to have announced. You have said in your direct testimony that compression of a gas warms the gas, so that when passed into the condenser there is a bigger difference of temperature than there otherwise would be. And you continue by saying that, in other words, the condenser would work more readily than if it was condensing at atmospheric pressure.

Now, my question is as to whether the real effect of compression, in aiding condensation, is not the heating, but is the raising of the point at which the gas will condense—that is, the gases will liquify at a higher temperature when under compression than if under atmospheric pressure?

A. Your statement is correct, but the implication that mine is incorrect, is not a necessary inference.

Q. It seemed to me that the two statements were contrary to each other.

A. They are not.

Q. Well, you appear to me, in the testimony that I quoted, to be giving a reason why a condenser worked better when the gases were under pressure, or compression. Did you give the correct reason? It seems to me that if my statement of the situation is a correct one, it would necessarily follow that yours was the incorrect one, because the heating of the gases—if that is the effect of compression—would not aid in the condensation, but, rather, the reverse?

A. Both statements are correct, and I will explain how.

Q. How do you reconcile them?

A. The major heat to be separated is the latent heat, rather than the sensible heat, and, accordingly, when the product is under pressure, as you have said, and the boiling point is raised—of the liquid—we have a great difference between the cooling liquid—say, water—and the boiling point of the gasoline which is being condensed. Consequently we have greater difference—we have a more ready condensation—that is, transferring of heat, one to the other.

In the particular case that I was mentioning, Hall was compressing his gas *just* before condensing it, so that the heat of compression would be carried into the condenser. If he had not done that he would be condensing at atmospheric pressure, and, accordingly, his compression, thereby, permits the use of a smaller condenser than it would otherwise have, due to the fact that he heats up his gas by his compression, thereby making a greater difference in temperature between the cooling water and the other. For you [fol. 394] must take the same number of heat units out of the gas, from its latent heat in one case, as in the other. That is, in the case of atmospheric pressure, or in the case of higher pressure, such as Hall uses in his condenser.

Accordingly, by use of his compression he gets the higher temperature, and the conditions which you have mentioned, and gets this larger differential between them, which he would not have if he had atmospheric condensation, as he would have had if he did not compress.

The difference is not a question in the Hall process, between carrying it out under pressure, at an ordinary temperature and atmospheric pressure, and the same temperature before condensing, but it is a case where he, by compression, has changed the volume of the gas, thereby raising the temperature and making a greater differential of temperature between the gas and cooling water, and accordingly, making less cooling water, and a smaller sized apparatus available for the condensation.

Q. I can see that the compression does good under those circumstances, but would he not have been even better off if he had compressed without warming the gas?

A. That compression without warming the gas is like saying two and two makes six. It cannot be done.

We are using a hypothetical condition, which is an impossibility. It would, of course, be better, by using that same hypothetical condition, if he could have compressed it and cooled it down, so that it would not have required the use of cooling water, but we don't know that kind of a compression.

Q. But the warming of the gas, itself, is not an advantageous feature, but is rather a disadvantage, isnt' it?

A. It is, at the instant, but it is not, ultimately, because you must remove a certain amount of heat, in order to get it as liquid. If you have it at atmospheric pressure, and say at a hundred degrees Centigrade, the temperature of boiling water, and in order to cool it to a liquid at room temperature—we will say 20 degrees Centigrade—if we take that gas and compress it we will be able to accomplish the re-action with a greater difference between the cooling water and the other, than if we do it without compressing.

Or, to put it in another way, we have a certain number of B. T. U.'s to remove, whether we have it under pressure or at atmospheric pressure, and we can do that easier with a greater difference of temperature between the cooling water and the gas to be cooled.

[fol. 395] Q. When you warm the gas that gives you more B. T. U's to remove, doesn't it?

A. Not in bringing it to a liquid. For example, if you will compress it high enough, there, you can bring it to a liquid without removing any B. T. U.'s.

Q. What becomes of the energy that you put into the compression?

A. Part of it goes as friction, and part of it into your gas.

Q. As heat?

A. As heat.

Q. And you have to remove that?

A. Yes, you have to remove it. You have a larger differential between your vapor and your water, as I have said before, and that differential permits you to carry it out easier.

The Master: What do you mean by "easier"?

The Witness: I mean that it can be done with less water, and with a smaller apparatus.

The Master: How about time?

The Witness: Your time will be—yes, you will use the same apparatus with less time.

Q. That is, the more heat you put in the less you have to remove, is that it?

A. No. The amount that you put into it by your compression, there—using the ordinary type of compressor—is minor, compared with the other factors.

Q. But there is no advantage in putting in more heat, is there?

A. There is no advantage, essentially, in that portion that you put in, but there is advantage on the question of bringing the particles closer together, so that they will condense more readily, and have their boiling point raised.

The Master: In other words, you consider the advantages of the compression overbear the disadvantages?

The Witness Yes.

Q. You have said in your direct testimony, that by putting ice under pressure you will raise its temperature.

A. Yes.

Q. Where do you get that idea?

A. It is a statement made in many of the books on college physics, and can be, perhaps, easily illustrated by the fact that if you will take a piece of ice—say a block of ice, and put a wire over it, or a string over it, and put a heavy weight on it, that wire will cut through, and the ice will freeze about it, showing that it has become liquid in the [fol. 396] intermediaę portion. That is a standard sophomore physics experiment, to show that pressure will melt ice.

Another case of it, of historical importance, was the work that was done in Canada, where an Army shell was filled with water, and a tap threaded into it, so that it was completely closed. This was put out in the cold, and it was found that it did not freeze, even at a quite low temperature, and then, finally, at a very low temperature—something like 25 or 30 degrees below zero—it cracked, and when it cracked the water shot out, and apparently froze instantly, because we had it coming out as if from here (indicating) and a sheet of water, like my hand, sticking out, in the form of ice. In other words, it was liquid at the

instant it came out, and the pressure had prevented it from freezing. Which is the converse of the statement that I have made there.

Q. Now, getting back to this ordinary, common experiment that you have referred to, where you had a piece of wire over a block of ice——

A. A piece of string.

Q. A piece of string over a block of ice, and a weight on the string, so that the ice was, at that point, put under pressure—did you mean to say that the pressure raised the temperature of the ice?

A. Yes. The pressure, there, melted—it did not, perhaps, raise the temperature of it, but it did change it from a solid to a liquid—which is the statement I made on page 466 of the typewritten record. I didn't say that it changed the temperature.

Q. On that same page you were asked a question: "Where you compress the ice, it would raise, or lower its temperature?" Answer: "We would raise its temperature."

A. In that case we have—that being not the answer to the question which you earlier discussed, but the answer to another question.

If we put a material under pressure we will, normally, raise its temperature. A very good illustration is that where small boys put two pins on a railroad track, and letting a train run over them—it compresses them, and when they take them off they are so hot they cannot handle them. And, similarly, if we take ice and put it under a hammer, or give it pressure, it, like any other material, will be raised by the effect of the pressure. It is exactly the same thing as you spoke of a moment ago—of the compressor—where does the heat of the compressor go? Part of it goes [fol. 397] into friction, but part of it is absorbed by the material. It is exactly the same thing—whether it is a gas or a liquid, or a solid.

Q. Referring again to the part of the testimony that we were looking at—don't your two answers on that same page mean the same thing? One of them talks about putting the ice under pressure, and then the next question talks about compressing the ice, and you say that that would raise the temperature. Is that a correct answer?

A. I think that the second answer is, without any question correct. The first answer—we can change it from a solid to a liquid—is accompanied, probably, by a slight rise of temperature. I have seen figures calculating that, and I think you will find that in Ganot's Physics—one of the older books on physics—as giving a fraction of a degree Fahrenheit. The figure I have in mind is six thousandths of one degree of a temperature rise, for a certain weight which was used.

Q. Then am I right in understanding your testimony to be that there is a temperature rise of the ice, when you put it under pressure, or compress it?

A. Yes, unless you take some care to remove the heat which would be given to it.

Q. And that increase of temperature takes place in such an experiment as that of the weighed string, that you spoke of a moment ago?

A. Yes, sir. As I said, as I recall the figure, it is six thousandths of one degree, Fahrenheit.

Q. Increase in temperature?

A. Yes, sir.

Q. Now, you referred to one other experiment in this connection, a few answers ago. Doesn't that show that the pressure does not raise the temperature, but lowers the melting point?

A. That is probably true, as well. I would rather put it this way: It is true that the pressure would lower the melting point of such material as expands on freezing. If it contracted on freezing, it would not. There happens to be only a very few materials that expand on freezing—less than one per cent—and it happens, also, to be that water is one of those.

Q. Isn't it true, Professor, that this experiment of the string and the weight shows, not that the temperature has been raised, at all, but that the melting point has been lowered?

[fol. 398] A. It is possible, but my recollection is that the figure given was a plus—that is, that it was the amount of heat locally involved. The figure was actually determined experimentally, I think.

Q. I find in Ganot's Physics, that it is stated that an increase of pressure on ice lowers the freezing point; is that true?

A. Yes, and that is what I stated a moment ago,—the second question before the last.

Q. You also had previously stated that it raised the temperature.

A. That compression did raise the temperature, yes.

Q. Do you still think so?

A. Yes. I think that practically any material—that if you put it under high pressure you will find that some of the effort that you have put in, just as in this air compressor that you were talking about, in the Hall patent—some of it goes to add temperature to the material. In fact, we have in general use, in the hydraulic press, an apparatus where we use high pressure and if we want to avoid a rise of temperature we have to go to quite roundabout schemes to take away the heat—to remove the heat that is given by the compression.

The Master: What is the fact about the compression of gases in cylinders, like, for instance, nitrous oxide gas compressed in cylinders, sold to dentists—when that is released is there a freezing temperature on the nozzle of it?

The Witness: Yes. That is due to the release of pressure, which is the reverse of the compressing of it.

Q. But you cannot heat ice above its freezing point, can you?

A. No.

Q. How could you increase your temperature by this pressure that you put on it?

A. As we increase our temperature a part of the ice will melt.

Q. So that you can not increase the temperature?

A. In that sense, that is correct.

Q. But the freezing point lowers?

A. Oh, not necessarily, the freezing point lowers, but we have melted part of our ice.

Q. The freezing point under the weighted string is lowered, isn't it?

A. Yes, there, but the pressure does add heat to it there. The energy that you put into your compressing apparatus, part of it goes to added heat.

[fol. 399] Q. But not to raise the temperature of the ice?

A. In that part of the ice coming under the string, it aids the melting—it would be melted in part.

Q. And the tempeature would be lowered, wouldn't it?

A. The temperature would be the same—the temperature of the ice would be at freezing point.

The Master: The temperature of the block, generally?

The Witness: Yes.

The Master: Apart from that place where the pressure was applied?

The Witness: Would be the same.

Q. The temperature of the ice under the wire would be lowered, wouldn't it—under the string, I mean?

A. Yes, subject to, possibly, minor——

The Master: The temperature under the wire where the pressure was applied, would be increased, would it not?

Mr. Neave: It is the melting point that is decreased. You can not raise, as I understand it, the temperature of the ice in that way.

The Master: In other words, you have generated a heat by the pressure of the wire, that melts the ice—is that it?

Mr. Neave: Not as I understand it, your Honor. The point I was getting at—so that we may make it clear, because it has some effect on other branches of the case—was that it does not increase the temperature, as the witness had previously said.

Q. In cracking liquid hydrocarbons under pressure, what is the function of the pressure?

A. To permit the raising of the temperature, without the material distilling off as rapidly.

Q. I think that you have said in some portions of your direct testimony, that the function of the pressure was to speed up the cracking.

A. By permitting you to raise the eemperature 20 degrees, which you can raise your temperature in chemical reaction, in general—I don't know whether this one applies here—whether it is 18, or 22, or something like that—we can double the speed of our decomposition—that is, of our cracking—and, accordingly, permit us to raise the temperature, say 20 degrees, which would double the speed of our cracking, so that the indirect effect of the raise of the pressure is to permit us to increase the speed of cracking.

Q. In some cases, at least, don't you have to raise the pressure in order that there shall be any cracking, at all?

[fol. 400] A. I presume you are thinking of kerosene, but that is not true if you use a vapor phase cracking, but only if you use the liquid phase.

Q. I am talking about liquid phase cracking.

A. Your question did not so limit it.

Q. Then, let us see what you mean by that. In the liquid phase cracking you sometimes have to have a pressure in order to get any cracking, at all, do you not?

A. Of the materials which are commercially cracked—even such a material as kerosene—and we crack very little kerosene, compared with what we do in higher products—probably only a few per cent—we get cracking even at atmospheric pressure, without using anything above that pressure—in the liquid phase cracking.

That is, perhaps, best illustrated if we will take and distill a kerosene—we have a residue. The product that comes over may be water white. If we take that and even again re-distill it, we will have a darkening of the surface of the flask, showing that some of the higher boiling products have been formed, and if they are higher boiling we will expect some lower boiling, and this carbon film on there, indicates that cracking has taken place to, to be sure, only a minor extent.

Q. Only a minor extent of the cracking of the kerosene?

A. That the distillation of kerosene at atmospheric pressure has brought about cracking, but only to a minor extent.

Q. You spoke a moment ago about the vapor phase cracking—what is the function of pressure in vapor phase cracking?

A. It permits you—by doubling the pressure you get double the quantity in a given apparatus. That is one, and, perhaps it is the most important aspect.

Q. Is it to speed up the cracking?

A. Yes, it would have the effect of speeding up, because you would be bringing your molecules of the gas into contact with the hot walls, more often, and into contact with other hot molecules more often, so that this question of getting more material into the vessel would mean the speeding up of the re-action.

The Master: There are three factors used in disrupting molecular structure of oils, as I understand it—pressure, temperature and time. Is that right?

The Witness: Temperature and time are the primary [fol. 401] ones. Pressure is of minor importance, itself, excepting that it permits, for example, with liquid phase, higher temperatures. On vapor phase we have these factors that I have just mentioned. It is useful and important, but of minor importance in the liquid phase process, excepting as permitting higher temperatures to be used.

Q. In the Young, British patent, No. 3345, 1865, I find that he states that the vessel that he uses in his process, "may be made of iron, or other metal, capable of withstanding 100 or more pounds to the square inch." And, again, I find that he states that his vessel, "to insure safety, should be made of sufficient strength to resist a pressure of at least 100 pounds to the square inch." He further states, as you have pointed out, that he uses a pressure of about 20 pounds, in practice. That is a ratio of 5 to 1, as compared with the strength of his still. That is what you would call a factor of safety, is it not?

A. Yes.

Q. Is that a usual and commonly accepted factor of safety, in things of this sort?

A. I am not certain just what you mean by "things of this sort"—whether you mean mechanical appliances, or——

Q. No, no—pressure vessels that are to be heated, in creating pressure.

The Master: Steam boilers.

A. I would say that that is rather a high factor of safety for such pressure vessels, that most of them will be constructed with a factor of safety of around 3, or 3½, though we have, for some uses, cases in which they are constructed with a factor of safety, or two, or even one and a half.

Q. Boilers?

A. Not boilers, but for some other appliances. I think my recollection is that steam boilers have a factor of safety of around 3½, as the customary factor. However, I am not a steam boiler expert.

The Master: Has the factor of safety been reduced since the perfection of safety pressure valves?

The Witness: I think it has been reduced, particularly in those types of boilers which are tube boilers, rather

than those which are of the, say like the Scotch boiler, or the marine boiler, with a large volume of water in one vessel.

Q. If you knew that a pressure still was to be made of metal capable of withstanding 100 pounds to the square inch, you would know that it was not to be run at that [fol. 402] pressure, wouldn't you—you would figure in your factor of safety, wouldn't you?

A. Yes, you would figure in your factor of safety. It would depend a little bit on what your context was. If it was to be tested hydraulically, at a certain pressure, then you would expect to work it at a lower pressure, and the one pressure divided by the lower pressure would give you your factor of safety.

Q. If these oil stills explode it is rather disagreeable, isn't it?

A. It is bad.

Q. So that you must have a proper margin of safety?

A. Yes. It is like a steam boiler explosion in it——

Q. Or worse?

A. Or worse.

Q. Under those conditions would you apply a five-to-one factor of safety? That seems to be what Young used.

A. I would say that that was a very safe factor of safety.

Q. What factor of safety do they actually use—do you know?

A. I don't know. It would depend on the type of still particularly, as to what would be a proper one. One in which the bottom was to be heated red hot, must have a very high factor of safety, when used at ordinary temperature.

Q. As Young says, in his patent, that his still should be made of iron, or other metal capable of withstanding 100 pounds to the square inch, so I find that Barbet, in his French patent, No. 322,265, says:

"The boiler is of thick plates, of a style capable of supporting five or six atmospheres of pressure."

You would understand from that, would you not, as in the case of Young, that he was not proposing to operate at those pressures, but that he was allowing a reasonable factor of safety?

A. I would say not, because here he is describing the operation of the plant. You will notice the next few words—"the pump X, forces the exhaust crude petroleum into the boiler, P." I would say that this was a discussion of the operating pressure, and not of the pressure when tested cold, hydraulically, or otherwise.

Q. He is not talking, much, about operations, when he says that the boiler is of a thick plate, and of a style capable of supporting five or six atmospheres of pressure, is he?

A. That is a preliminary sentence, just at the beginning [fol. 403] of the paragraph, in which he discusses operation. All the rest of the paragraph is concerned with operation.

Q. Except the preceding sentence?

A. I say all the rest of that paragraph.

Q. Excepting the sentence just preceding the sentence that I quoted.

A. Well, that would be—the rest of it. In that paragraph there is no sentence preceding it.

Q. The first sentence that I meant, was the statement that there is a cylindrical boiler provided with an agitator—that is structure, isn't it?

A. That is only a part of the sentence.

Q. That is structure, isn't it?

A. Yes. This sentence is a structure sentence, preliminary to describing an operation. The whole paragraph is concerned, primarily, with operation.

Q. Now, outside of the statement in this Barbet patent that "the boiler is of thick plate, of a style capable of supporting five or six atmospheres of pressure"—what statement do you find in the Barbet patent, as to the pressures that are actually used in that cylindrical boiler, P?

A. Using, first, the sentence which you have mentioned—"the thick plate"—if it was only five or six atmospheres—five atmospheres would be 75 pounds, tested hydraulically—it would only need to be a plate of approximately the thickness of the lead of my automatic lead pencil—in other words, a sixteenth of an inch—and that would not be a thick plate. For example, an ordinary fifty-gallon steel drum, made of rather thin gauged metal, of the ordinary type, is not much thicker than a piece of ordinary

blotting paper, and readily stands a pressure of five atmospheres, without any bursting, and it is used in manufacturing plants, occasionally, at that pressure.

So that the statement of a thick plate, itself, would show that the five to six atmospheres, in such a drum—and we have it that that drum, here, is essentially of the same character as a shipping drum, such as I have mentioned—would mean a contradiction in there—if it was thick plate, for the purpose of withstanding five to six atmospheres, hydraulic pressure—that is, cold.

On the other hand, if it is to withstand a pressure of five to six atmospheres, as an operating pressure, where the drum gets hot, and must, thereby, lose considerable of [fol. 404] its strength, then it would be necessary to have a thick plate—that is, the entire thickness of my lead-pencil, or possibly thicker.

The Master: In other words, you think that he is giving the working pressure of the boiler, capable of withstanding a working pressure?

The Witness: Yes, sir.

The Master: And have figured his factor of safety above that?

The Witness: Yes, because all the rest of the paragraph is concerned with operation—with working—and it is only this first preliminary one that describes the apparatus, alone, and does not mention the operation.

The Master: He leaves the amount of the factor of safety to be determined by the practitioner?

The Witness: Yes. The other seven sentences are concerned with operating, and I think we should imply that the eighth sentence, which is the only other sentence in this paragraph, should also be considered as operating.

The corresponding United States Patent, No. 836,732, of Barbet, states, on page 3, line 34:

"Preferably a pressure of five or six atmospheres is maintained in the boiler, 7 and at this pressure of five or six atmospheres the cracking takes place more rapidly than in the black pots, at ordinary pressure."

So that that would confirm it. That is all the answer.

Q. Now, referring to this same Barbet, French patent, No. 322,265, and especially the figure 1—I want to be sure

that I understand as you do, the operation of this arrangement.

The cylindrical boiler, M, down at the lower right-hand corner, is damaged with oil and is heated, and the vapors rise up in a tower, H, above, do they not?

A. They do.

Q. Now, that boiler, M, is under atmospheric pressure, is it not?

A. I presume so. I don't recall any statement as to any particular pressure.

Q. So that the distillation occurs and the vapors rise through the tower, H, and the illuminating portions are separated out into the separators, at the right-hand side, marked O, O′ and O″, which take, respectively, the heavy, the intermediate and the lighter illuminating portions, do they not?

A. That is correct.

[fol. 405] Q. And the lighter vapors go out through the top of that tower, H, and H′, do they not?

A. Yes.

Q. The residue in the boiler, M, goes by the line indicated at the bottom of the figure, over to the left, and into the boiler, P?

A. By means of the pump.

Q. By means of the pump, X—is that right?

A. That is correct.

Q. Then the boiler, P, is subjected to heat, and some pressure—I am not now inquiring into the amount of pressure—and the vapors from that boiler go into the bottom tower, Q, do they not?

A. They do, through the valve, Z.

Q. Through the valve, Z. Then, those vapors pass upward in the tower Q, Q′, some of them, and the liquid is removed from the bottom of the tower at the point marked x?

A. Some liquid will be there but it is not my understanding that the liquid which passes out form x is exclusively, or even any large part of it, from the vapors, Z, passing through the pipe and valve, Z.

Q. Then, still confining our attention to the vapors that come over through the valve, Z, and boiler, P, some of those vapors go to the condenser, V, and are condensed and drawn off at 10?

A. No.

Q. None of the vapors go out through the condenser, V?

A. No, it is liquid that goes out through the cooler, V. V is not a condenser.

Q. Some of the vapors that come over from the boiler, P, through the valve, Z, condense and pass out through the cooler, V, do they not?

A. Yes.

Q. And the balance of the vapors that came over from the boiler, P, through the valve, Z, go up into the receptacle, R, which is a partial condenser?

A. Yes.

Q. And the portions that are condensed in that receptacle, R, pass down by the tube, u, u', and the tower, Q', and the lighter vapors pass out from the receptacle, R, at the points, t, and go over to the tower, H, do they not?

A. That is correct, but your implication all the way is as if we were dealing only with the vapors from the cracking still, P, which is, of course, an incorrect one.

[fol. 406] Q. I am coming to the other materials from that still now.

Now, those other materials that come over from the still or boiler, P, issue from it at the point, y, and enter the tower, Q, at the point, z, do they not?

A. They do.

Q. And when they enter, I understand that you have said that they flash into vapor?

A. In part.

Q. Yes. And the heavy portions are drawn off through the valve, x, at the bottom of tower, Q, are they not?

A. In part.

Q. And then, some of the other portions, the intermediate portions go into the cooler, V, and are drawn off at the point, 10, are they not?

A. That is correct.

Q. And the lighter portions go up to the receptacle, R, do they not, the partial condenser?

A. I would not call them very light, by any means.

Q. Well, they are vapors that get up there?

A. Yes, but they are lubricating oils and gas oil range, and such as that.

Q. And they are lighter than the products that come out through the valve, x, and that go into the cooler, V?

A. They will be in part, the same as going into the cooler, V.

Q. But on the average, and taking it all through the mass that goes up——

A. For example, their gravity would be lighter there.

Q. Yes.

A. Though they will contain constituents that do go into the vessel, V.

Q. So that these vapors from the material that entered the tower, Q, at Z, go up with the vapors that left the boiler, P. through the valve, Z, together go up to the partial condenser, R, do they not?

A. They do.

Q. And the heavier portions of all of these vapors are condensed in the partial condenser, R, and go back through, u, u', to the tower, Q, and the lighter portions go as vapors through the pipe, t, t', to the tower, H?

A. The major portion of them do, not all of them.

Q. Where do they go?

A. They go out through the pipe, t, t'.

[fol. 407] The heavier portions do not all condense through, V, and go down through, u, and u', but only a part; the major part, to be sure, but we would have, passing out through, t, and t', the major portion of the light vapors, and the minor portion of the heavy vapors, because this is only an ordinary type of dephlegamator, and as such, it is not an effective separating agent. It is simply built like an ordinary condenser, this vessel, R.

Q. The vapors have been well fractionated in the tower, Q, Q', before they go into R, have they not?

A. The top plate of Q, Q', is wet with the liquids which come from the condenser, R, u, u'; accordingly, all of the vapors passing up through it will be fairly heavy vapors. If your statement was correct the inlet, u', would be placed two or three plates lower and not at the point where you put it.

Q. Why do you say that, Doctor?

A. Because if they wanted to have the light vapors on the top plate, they would do as they ordinarily do with a reflux, run the reflux in at the third of fourth plate, rather than at the top plate.

Q. Do you know of any instance in the oil industry in which the reflux is run into the third or fourth plate of the tower?

A. I think, as I said once before, that the oil industry is very much behind in its use of bub-le towers and of refluxes.

For example, in the case of the Lewis and Clark bubble tower, as it has been expressed there, we could accomplish, with a structure only one-fourth the size, the same separation if we would use the reflux.

Q. Do you know of any recognized present-day authority that claims you should put the reflux in between the third or fourth plate, or below the top plate?

A. When we wish to have the top plate covered with light liquors, Barbet does, and he is probably as high an authority as we have.

Q. Barbet was in 1902. Now, do you know of any practice that puts the reflux where Barbet puts it?

[fol. 408] A. You mean the third or fourth plate, or do you mean at this top plate?

Q. I beg your pardon. Change that question:

Do you know of any present-day practice that puts the reflux in between the second and the third or the fourth plate?

A. Yes.

Q. Where?

A. The largest stills in the country are, I think, those at the United States Industrial Alcohol Company of Baltimore, and they are partly of Barbet design, and partly of Guillaume design, and it is my recollection that the reflux is at the third plate.

Q. That is not the oil industry, is it?

A. Your question was not limited to the oil industry.

Q. Well, it was not the oil industry, was it?

A. No, the oil industry, as I say, is very much behind in the use of bubble towers.

Q. Who is it that is up to date?

A. Almost every other industry that uses bubble towers and refluxes is up to date.

Q. Would you not think that that shows some difference between those industries, rather than that the oil industry was behind?

A. No, because it has only been a few years that the oil industry has been using refluxes and bubble towers at all; whereas, the other industries have been using them for forty years.

Q. Now, where do you find in this Barbet French patent, No. 322,265, any indication that anything other than vapors go out through the pipe, t, t'?

A. I did not say that it went out as liquid there. I said that it contained some of the higher boiling products.

Q. Barbet says, does he not, that "the illuminating vapors leave the condenser, R, by the nipple, T, and by the tubes, T, T'?

A. Yes, and the next line says, "Where they are refined", which they would never be if they did not carry heavier materials with them.

Q. You have omitted something there, I think.

A. "Go to the column, H, H'."?

Q. "Go to the column, H, H', where they are refined and classified."

Now, when these vapors get from the tubes, t, t', into the tower, H, H', they are classified and refined in that tower, [fol. 409] the heavy, intermediate and light illuminating fractions going into the receptacles, O, O', and O", for classifications and other portions pass off through the top of the tower, H, H', in the refining operation, do they not?

A. In part. It is to be noticed that, t', is below the plate. I think it is, S_2, there, from which the product is drawn off to the receiver, O_2, containing the heaviest of the illuminating oils. In other words, the fact that that is placed below that would show that there was something to be taken out of it, and it would pass down the column as it is carried down by the reflux operation of the tower, a reflux operation that is started by the dephlegamator, F.

Q. But there are vapors that come through the tube, t, t', into the tower, H, are they not?

A. Yes.

Q. And through that tower, H, they are continually rising, these heated vapors from the boiler, M, are they not?

A. Yes.

Q. Do you find anything in the Barbet patent that shows that anything from these vapors that come over through t, t', going downward instead of upward?

A. Yes.

Q. What?

A. The position of the entrance of the pipe, t, t', in Fig. 1, shows that, because the vapors here are passing in and then are washed by the liquids above. There is a downward current, it must be borne in mind, of liquid materials passing through the column, H, H', as well as an upward current of vapors which you have mentioned.

This downward current of liquid is for the purpose of washing the vapors as they come out, and particularly in this case for washing the heavy materials out of the vapors, condensing them to liquids that come over from the column to the left, or from the dephlegamator, R, to the left.

Q. Then, most of that liquid stream that comes down through H, from whatever source it starts, is again vaporized when it get to M?

A. A part of it would reach the boiler, M, have heat applied in part vaporized, and in part returned by the pump, X, to the cracking still, P.

Q. Do you find anything in the Barbet description, specification or claim, that indicates that any of the vapors, or any of the materials contained in the vapors coming over through t, t', ever go down to the boiler, M?

[fol. 410] A. The very fact that H is given as a column, would show that would be expected.

It is to be noted (I am reading now from paragraph 15, which is of the French, page 2, begins at line 78):

"The purified petroleum leaves the heater, F, in J; it reaches a temperature much higher in the boiler, G."

We would perhaps make a better translation and call it "Pre-heater," G.

"An- enters at the feeding plate of column, H, and this feeding plate—"

"The methodical boiling of the successive plate of H provokes the total evaporization of all lighting oils, and even an oil of the paraffin products. The separation of all these vapors is produced on the plates, H, exactly according to the same law as at all times in the purifier."

Now, we have here that they consider, apparently, the vapors coming over from the condenser, R, in the same sense as they do the hot crude oil coming through the heater, G, because they permit the two to enter on the same plate, and as such, it would mean that the materials coming over from t, t' are not pure illuminating oils free from such materials as lubricating oils. They certainly carry other materials.

Further, the water in V, the cooler that we mentioned, is carried at such a temperature (I am referring now to page 5 of the translation, two paragraphs after the discussion on five to six atmospheres);

The water, V, must be maintained at least at 70 degrees to prevent all solidification of paraffin.

If they were running through V, the gas oil, for example, there would be no fear from the question of paraffin separation.

Mr. Cooper: "The water, F, must be maintained"—excuse me, Doctor.

The Witness: "The water of V must be maintained at least at 70 degrees to prevent all solidification of paraffin." This is in the original French, line 102.

Q. Page what?

A. Page 3.

Q. All right, there is a mistake in the translation.

Mr. Cooper: Yes, I was just following the other translation, Doctor.

A. (Continued). And if there is any danger of paraffin solidifying in V, it shows that they are not running gas oil, [fol. 411] for example, through V, but the gas oil, as the next outlet, must go through t, t', into the still H, and as such then, t, t' that pipe, must carry gas oil as well as illuminating oil and as well as gasoline.

Q. Would not the material be the mixture paraffin and gas oil?

A. It might, but there would be practically no danger of its solidifying if it was such a mixture from a crude oil; that is, there would be sufficient gas oil present so it would all be in solution.

Q. The statement of the specification of the Barbet patent is that it is, "the illuminating vapors which leave the condenser, R, by the pipe, t, t''"; that is true, is it not?

A. Yes, but it is followed by the statement that, "they go to this column, H, H, where they are refined." If they are to be refined, it would mean that they are to be purified and probably from gas oil, because they are run in at a lower point, not at a higher point, than the outlet to the condensers.

Q. Then, when the vapors enter from the pipe, t, t', into the tower, H, in order to be classified into O, O', and O'', they pass upward, do they not, to the various fractionating plates and out through the pipes marked, s, into those receptacles, O, O', and O''?

A. In part.

Q. So far as the tower, Q, Q', operate at efficient fractionating apparatus, they are only illuminating fractions which pass off through t, t', and there would be no fractions heavier than illuminating fractions passing through that pipe?

A. No. This tower, Q, Q', is intended to separate out the lubricating oils and paraffin-car-ying materials, as is shown by the cooler, V. It is probably efficient for the purpose for which it was designed, and that is a separation of the lubricating oils from the middle of the tower and into the cooler, V, and the passing over above that of the illuminating vapors which were the only things of real commercial value at that time (1900: Gasoline was not the primary product, nor gas oil), and the passing over of these vapors, together with the gasoline; though nothing is said about gasoline, it must of course go; nothing is said about gas oil, it must of course go, because there is no place for it excepting through that pipe t, t'.

Q. And that is the illuminating vapor, is it?

[fol. 412] A. Illuminating vapors, gasoline vapors and gas oil vapors.

Q. Are they all illuminating vapors?

A. They are not all illuminating vapors. The illuminating vapors are spoken of because they are the ones which

have commercial interest, and which it is of interest to set out. Of course, paraffin is spoken of in the cooler, V, because it is of commercial interest and it is watched to see that it does not crystalize out and clog the apparatus.

Further, there is no more evidence that the gas oil does not pass out through t, t', than that the gasoline passes out; both must pass out through there.

Q. Suppose you condensed and inspected the vapors coming over through the pipe, t, t', what would you expect to find their end boiling points to be?

A. Around 100 degrees Fahrenheit.

Q. The upper end point?

A. Oh, the upper end, not the lower end?

Q. Yes.

A. Oh, perhaps 700 Fahrenheit.

Q. What would you expect to be the initial boiling point of the material that goes into the cooler, V?

A. Probably 550 Fahrenheit. That is, there would be an overlapping between the two, of course.

Q. Then, the material going into the cooler, V, would have gas oil in it, would it?

A. Some, but very little; otherwise, you would not have any separation of paraffin.

Q. Now, if any of the material passing over through H, through the tube, t, t', goes baack into the boiler, M, and thence over to the boiler, P, that portion would be only the heavier portion of the illuminating oil fractions, would it not?

A. It would be the gas oil, essentially.

Q. How about the answer to my question: Only the heavier portions of the illuminating fractions?

A. It would be only the heavier portions of the vapors passing from the pipe, t, t', if you call that the illuminating fraction, that is because it contains the illuminating oils, I would say "yes." It would be essentially the gas oil material.

Q. So that it is only, according to your view, a portion of what is vaporized from the material that passes from the [fol. 413] boiler, P, through the outlet, Y, which ever gets back to the boiler, P?

A. That is correct.

Q. How small a portion or how large a portion, having in mind that some of the material that comes out through, y,

into the tower, "Q, goes out through, x, at the bottom of the tower, and also goes out through the cooling chamber, V?

A. I would say that it would be essentially all the gas oil fraction, that is the part that would go out through x is for higher boiling than gas oil. The part that would go out through V carries a little gas oil, probably, though we cannot tell from the context. It may be free from gas oil, but I would expect it to carry a little gas oil, say five or ten per cent of the gas oil.

Q. It might contain all gas oil?

A. No, it could not.

Q. It could not? Why not?

A. Because they have to keep the temperature at seventy degrees in order to keep it from solidfying, and the portion the gas oil which is present is sufficient in such material—the gas oil fraction is sufficient in order to keep it in liquid condition at ordinary temperature, if it would go out through the cooler, V.

A mixture of gas oil and the lubricating oil carrying paraffin, taken in proportion as they come over the still, would be one which would be liquid at ordinary temperatures and not have to require the use of warm water to condense it. Sometimes, in order to get paraffin to condense out we must chill it with an ice machine, but ordinarily the Barbet product is so high in paraffin that even chilling to ordinary temperature is sufficient to cause it to solidify.

Q. And you understand that the product that goes into the cooler, V, is a product which would have a chill test of around seventy?

A. No, not quite. It may have a chill test of even higher than this, because the water must be maintained at least at seventy, so that the liquid would probably be ninety degrees. It would probably have a chill test of ninety or one hundred degrees Centigrade, and this——

Q. I beg your pardon?

A. That is not quite what I mean. The water is kept at seventy degrees, and this, it is to be noted, is seventy degrees Centigrade, so that our seventy degree chill test, which is a seventy degree Fahrenheit, has no connection [fol. 414] with it. If the water used was cold water, though water at, we will say, five degrees or ten degrees Centigrade, then the author here says that we will have solidifica-

tion or paraffin. Ten degrees Centigrade would mean cooling of the liquid inside to perhaps twenty-five degrees Centigrade, and that would be seventy-seven degrees Fahrenheit, and that would be, as the author says, dangerous.

Q. Referring, again, to the Barbet French patent, No. 322,265, would there be any gas oil in the separators, O, O′, and O″, or any of them?

A. On page 4 of my copy of the translation, it says "in S, and S′, and S², one will withdraw heavier and heavier lighting oils. These are cooled respectively in coolers, O, O′, and O².''

I would understand that the three grades of oil that are mentioned are grades of illuminating oil, and that probably the heavier oil would carry a trace, only a small amount of gas oil,—that is, of the heavier fraction—but only a very small proportion of the total of that, which would normally be considered a gas oil fraction.

Q. Just what distinction do you draw between gas oil and illuminating or kerosene oil?

A. Essentially one of volatility. It is partially measured, or can be measured by means of gravity, though he is measuring here by temperature.

[fol. 415] Q. And you would determine that there was only a trace of gas oil in one of these separators?

A. I would say that at that date it would be counted as illuminating oil, for this part—heavier illuminating oil. But in some specifications and plants this would be considered as containing some of what we know as gas oil.

Q. Yes, but how would you determine that there was only a trace of gas oil in O?

A. By the question of the measurement and gravity, or by the temperature at which it distills, or some of those things.

Q. What makes you think there would be only a trace there?

A. Because they are using it as a kerosene—as a lower grade kerosene.

Q. Isn't it possible that the heavier illuminating oil, in one of those chambers marked O, will contain everything that was heavier than the light end of the paraffin distillate?

A. I haven't any idea what you mean by the light end of the paraffin distillate. It is an indefinite term, used in

different plants and in different parts of the country, in different ways.

Q. You can consider that to be anything lighter than what goes through the cooler, V, of the Barbet patent.

A. No,—for, if that were true, the lower half of the column, H, would be useless, and it would be removed, and never installed—or, rather, I would say never installed, because the plates on the lower half of H must remain covered with liquid, and that liquid must be material heavier than the illuminating oil, and it would vaporize, because they are hotter.

Q. The plates would be kept full by the liquid, coming in from the receptacle, G, would they not.

A. But you have said that it was going to carry everything heavier, there, and that would be heavier, in part—that crude oil being fed in through G—the crude oil in heavier than the illuminating oil.

Q. I don't think I said everything—I said heavier, didn't I?

A. Yes, you did.

Q. I think you are right. I will re-frame the question. Is it not possible that the heavier illuminating oil in the receptacle, O″, would contain everything that was lighter [fol. 416] than the material that was cooled in V, and heavier than the materials in O and O′?

A. It is not possible, because each succeeding plate as we go lower is hotter, and it will be noted that the inlet at t′, and from G, both, are on a plate lower than the outlet to O″, and, accordingly, the plate beneath the outlet, S_2, will be hotter, by considerable, than the product that goes into O″, and, accordingly, we would expect—as undoubtedly does take place—that these vapors entering in from t′, and also from G, will lose their heavy constituents when passing up, and we will have part of them condensed in a plate where t′ enters in it, and also a part of them condensed on the next plate where S″ goes out, and those condensing where S″ goes out, will be, in part, sent to the container, O″.

Q. Now, returning to the matter that we were discussing yesterday, am I right in understanding that it is your view that shale oil gasoline and cracked gasoline from well petroleum, are substantially identical, both having about fifty per cent unsaturation?

Mr. Rauber: What is the basis of that unsaturation—is that in the testimony?

Mr. Neave: I think so.

A. I don't recall that I gave the figures as fifty per cent, excepting as from Allen.

Q. But is that your view that I have stated?

A. I think the percentage that you have mentioned is, perhaps, an average percentage, as between the two, but it is generally true that your shale oil gasoline will run higher than fifty, and that your cracked gasoline will run lower than fifty. Either one can be made to run either above or below fifty, as desired, by the operator and refiner. In other words while they are essentially identical, the different lots from even the same plant, or even from the same still, will vary in their percentage of unsaturates, and, in addition to that you will have varying percentages, due to the variation of the crude oil, and of the crude shale oil which you are using.

Q. Is the commercially cracked motor spirit made from Scotch shale oil, a water white, substantially gum free product, of reasonable odor, or strongly odored, and somewhat colored, so that it can not be stored for any considerable time, without deterioration?

A. It is a product of approximately the same color as what we normally speak of, in this country, as water white, and it can be stored, and is stored, in merchandising it, for motor use.

Q. It can be stored, and is stored for a considerable time, without deterioration?

[fol. 417] A. Without deterioration that would prevent it being used satisfactorily for a motor spirit.

Q. Is it a substantially gum free product?

A. Yes, substantially so.

Q. Is it of reasonably good odor, or is it strongly odored?

A. About the same as ordinary cracked gasoline from well petroleum.

Q. And for how long has this been substantially true?

A. Well, I saw it in 1920, and it was not shown to me as a new product, at that time. I presume that essentially, since motor cars became important, that there might have been such, just as there has been cracked gasolines from well petroleum, which were not properly defined, and gave considerable trouble in the carbureters.

Q. If the Burton process is used in the cracking of shale oil, would the gasoline be of high quality, or would it be strongly odored, and would it color on standing, and be inclined to carbonize in the cylinder?

A. The average gasoline would be strongly odored and inclined to carbonize, until it was refined, and on refining I would say that it could be made practically identical with the present day cracked gasoline, from well petroleum, made by the same process. I have, however, never seen either the product carried out by the Burton process, on shale oil, or the method of refining it in a particular factory in this country, using the Burton process.

Q. Would you expect the Burton process used in shale oil, to produce gasoline, to give you a gasoline like that produced by straight run distillation of well petroleum?

A. Yes, essentially so, but somewhat higher in unsaturated products, and, as such, they having the additional properties which those unsaturated products give.

Q. And how would the gasoline made by the Burton process, in cracking shale oil, compare with the shale oil gasoline produced at atmospheric pressure?

A. As I have said, I have never seen a Burton process working on shale oil, nor have I seen the product made from it. I would expect that cracking at atmospheric pressure would give essentially the same product as cracking under pressure would give. This is generally true, that cracking under atmospheric pressure gives the same character of product as the cracking under pressure gives. There are minor variations, but not much more than that of one—well, for example, in raw petroleum, petroleum from one field or another.

Q. In an article by you, appearing in the Chemical Age, of January, 1923, I find, under the heading of "Cracking [fol. 418] Crude Shale Oil," the statement that, "If the Burton process is used, the gasoline so made will not be one of high quality, it will be strongly odored, would color on standing, and will be inclined to carbonize in the cylinder." Is that statement right?

A. That is correct. I was comparing it with straight line distillation products, which was the high grade product of that day.

Q. The straight line of shale oil?

A. No, no—straight line of well petroleum, which was the high grade gasoline on the market at that date.

Q. Do you mean in 1922?

A. Yes, and is our highest grade gasoline, even at the present day. I think you will find, also, some similar statements in that shale oil book of mine, published only last June.

Q. Then, if you used the Burton process on cracking crude shale oil, you would get a product that was different from the product which you describe as being the cracked motor spirit made from Scotch shale oil, which was water white, and free of odor, and so forth?

A. The Scotch shale oil product you spoke of, was on the market directly, and it had been refined, a refined product, whereas, we are speaking, here, of a product directly obtained—primarily—and it is, moreover, even in the Scotch case, of strong odor, compared with straight line distillation, but not compared with the present day cracked gasoline from well petroleum. It is the same odor,—roughly the same color, and contains the same constituents as the cracked gasoline obtained from well petroleum. It is the same.

Q. Then in the statement that I quoted from your paper in the Chemical Age, about the Burton process, did you mean that the product that you were there speaking of, was a crude gasoline—crude, unrefined gasoline?

A. I was referring, primarily, to the distinction between the shale oil gasoline and the straight run, high grade gasoline.

Q. I find that you have stated in an article of yours in the Canadian Chemistry and Metallurgy, of January, 1923, that, "The shale motor spirit of Scotland even runs sixty per cent unsaturated, and, accordingly, it is strongly odored, somewhat colored, and cannot be stored for any considerable time, without loss of quality." Is that true?

A. That is a mistake. I did not write the article. Rather, I gave that article to Mr. Allen Rogers, and it was sent over, and they abstracted and cut it down, by nearly four-fifths, so that when I got it I scarcely recognized it as my [fol. 419] own. Mr. Rogers was the local secretary of the Society of Chemical Industry, to whom that address was given.

Q. This appears under your name?

A. It does. The editor—it was given, by me, to Rogers, and Rogers sent it to Longstaff, the General Secretary, and Longstaff gave it to an abstractor, and when he got done it was hardly to be recognized by its parent, he having cut down the article nearly four-fifths.

Q. Do you mean that Rogers put in something new?

A. No, not Rogers, but the abstractor gathered together various parts of it, in an attempt to remove four-fifths of it and leave the gist of it in the one-fifth, but he didn't get all the data on it.

Q. I find in the Journal of Industrial and Engineering Chemistry, for 1922, that you say that, "It is not surprising that when shale oil is further cracked to give a motor spirit, the product carries 60 to 70 per cent of unsaturated hydrocarbons." Is that statement of fact in the quotation, correct?

A. May I ask whether there was a co-author in that case—Rider or Goodwin?

Q. I don't see that you can blame that on anybody except the one whose picture goes with it.

A. No, this is mine. I think that that is correct. It was concerned with work done by Goodwin, in which the earlier part of the paragraph shows that it was essentially a hundred per cent unsaturated produce, to start with, which, on cracking, gave a sixty to seventy per cent.

Q. I see, also, in the publication, Canadian Chemistry and Metallurgy of January, 1923, a statement by you, that gasoline "to be a commercial gasoline, must, in addition, have but slight color, and be free from certain types of impurities." Is that right?

A. That is right.

Q. In the same publication and on the same page, I find this statement, that "cracked gasoline carried up to forty per cent of unsaturated compounds"—is that right?

A. I would like to see that, to see what the context is. I think it is right.

Q. That refers to gasoline from well petroleum, not from shale oil?

A. That, I think, is correct. It is referring to the cracked product made from petroleum, without having been mixed with any other gasoline, and when the cracking is carried to a fairly high degree.

Q. And just what did you mean "up to forty per cent"?

[fol. 420] You didn't mean from nothing up to forty per cent, I suppose.

A. No, but then the gasoline on the market was earlier put out carrying 25, and then some of it was increased, and I obtained some gasoline which was not mixed with others, which ran 40 and 42 per cent of unsaturates, by the ordinary tests.

Q. Tests by sulphuric acid absorption, are you referring to?

A. Yes, sir.

Q. Am I right in my recollection that you said that the cracking plant that you visited at Providence was using the so-called Burton process, but that it was not the Burton process? I haven't a copy of that testimony here, but that is my recollection of it.

A. I think that that would probably be a correct statement. I don't recall saying it, but I think that might be true.

Q. In what sense was it not the Burton process?

A. Well, it was the Dewar and Redwood process, or the Young process, and it goes back even further than that—a cracking under pressure, to which has been added the name of Burton, though there is nothing fundamentally new, to merit the name.

Q. You did not mean that it was something that was not described in the Burton patents, for instance?

A. I think it was—I think it is, too—at least to a considerable extent, described in the Burton patent.

Q. In the process that you saw there in Providence, what determined the temperatures employed? Was that a matter of free choice by the operator? If not, what was it that limited the choice?

A. I would say that it was essentially the pressure used.

Q. What determined the pressure, what was it that fixed it—why did they use that pressure, and not some other pressure, and that temperature and not some other temperature?

A. Because it had been mentioned in the directions to the operator, and he had been told to keep the pressure guage, I should judge, at a particular point.

Q. And what was there in that process, or in the working of it that you saw there, which would determine what temperature and what pressure was the proper one to use?

A. Only, I think, the question of the reading on the gauge, and the operator being told to keep it at approximately that pressure.

Q. I am trying to get back of that purely mechanical operation of the operator acting in accordance with instructions.

A. As to why they gave instructions?

[fol. 421] Q. As to what factors entered into the giving of those instructions as to the temperature and pressure.

A. I imagine they gave the instructions because, in the earlier operation of that same type of still, that pressure had been found a satisfactory pressure, and it had been found a satisfactory pressure because, by using that pressure you would get, on the one hand, a reasonable speed of operation, and on the other hand, not too severe cracking. In other words, it is an intermediate temperature, the pressure determining the temperature at which the oil was being heated.

The Master: Didn't they determine the pressure from the kind of stock they were operating on, and the kind of products that they desired to obtain?

The Witness: Yes, sir, but I think they operate with practically the same pressure on most stocks—that is, the pressure does not vary to amount to anything—except on kerosene stocks,—but I mean on most crude oil, or distillate stocks.

Q. In the range of pressure between 50 pounds and 350 pounds, what temperature would be employed in the process?

A. It would depend a little bit on the oil—not to any large extent, but it would be roughly from 700 to 850 Fahrenheit—possibly a little higher at the extreme pressure that you mentioned.

Q. And what effect would that have on the character of the cracking, whether you used the lower or the higher temperature, as distinguished from the mere difference in speed?

A. With the lower temperature you would get less carbon formation, in a given time, and in the higher temperature you would get more distillate. If you went to 850, or still higher, you would increase your carbon formation, and you would increase your amount of uncondensible gas.

Q. Would you get more coke per unit of gas formed, at the high temperatures?

A. You certainly would, if you went as high as twelve or fourteen hundred, and I am inclined to think that you would, even at 900, or 850.

Q. Would that be an important factor to consider in determining what temperatures to use, and what pressure?

A. Yes, it would be. I answered that, and said that in one of my earlier answers—that the speed was an intermediate speed, and one which would give a reasonable rate, and one which, at the same time, would not give too much—

Q. Yes, but within the range of the pressures that you have spoken of, using temperatures between 700 and 850, would the difference in the formation of coke, at one or the other of those temperatures, be an important factor in [fol. 422] determining what temperature to run at, and what pressure to use?

A. It would be a factor, but I don't know as it would be the most important factor.

Q. Now, there is one factor. What other factor would you put in to determine the temperature and pressure within that range?

A. We must have the temperature high enough to bring about decomposition—that is, cracking.

Q. Anything within that range would be that, would it not, within the range of 700 to 850?

A. Yes.

Q. So that that doesn't give you any choice?

A. Oh, you are referring strictly to within those two temperatures?

The Master: Yes, yes.

A. (continued). If you would use the lower temperature at the higher pressure, you would have trouble in making a separation by means of your reflux—your reflux would begin to operate on your lower boiling products and carry them back.

The Master: Some reference has been made here to uncondensible gases—what becomes of those gases—are they lost?

The Witness: They are hydrogen and methane, and so on, and they pass out from the valve beyond the condenser, and are generally sent back and burned under the stills.

Q. Was there a reflux used on those stills that you saw in Providence?

A. I don't recall that there was.

Q. And that plant was operating under commercial conditions, and was producing gasoline commercially?

A. I so understood.

Q. Then a reflux is not necessary, in your opinion, for that result—for present commercial operations?

A. We can operate without reflux, yes.

Q. In present commercial operations?

A. The extra cost of distilling would not be large, and would have some advantages. I would say yes, it would be possible to work it under present commercial operation, without a reflux. It would slightly increase the cost, but it would increase the quality of the product.

Q. What proportion of the vapors leaving the still were continuously returned by the reflux?

A. I said to you that I did not recall for certain that there was a reflux.

Q. You know that refluxes are commonly used on that so-called Burton equipment?

[fol. 423] A. I am not overly familiar with that so-called Burton equipment. I think this is the only plant that I have seen of recent years, even in a casual way, which carried or used that equipment.

Q. How would the presence of a reflux affect the process?

A. It would mean that heavier products would be returned to the still for re-cracking; it would mean that the vapors which would go over with the uncondensable gases would be, in larger percentage, the desired boiling points which are within the gasoline range, which would make possible the use of a smaller condensing coil, with smaller amount of cooling water, and it would mean, from a given outfit, a larger production per run of gasoline, inasmuch as some of that which is refluxed would be cracked afresh, and thereby increase the yield of gasoline.

Q. How would the presence of the reflux affect the gasoline production per hour from a given equipment?

A. It would probably decrease it some, because it would be returning cool oil to the still and thereby cool the still; the limit, essentially, being the amount of heat that you can apply safely to the still.

Q. In the Providence plant that you inspected, have you any idea how much distillate was taken off from the oil?

A. They took, I was told, a charge of 13,500 gallons, and the cracking process continued until only between 3,000 and 3,500 gallons remained in the still. This was as far as they could safely go.

Q. And that information was correct, so far as you could observe, or as you know?

A. Yes. To be sure, I was only there for an hour and a half in the plant.

Q. And there was nothing inherently wrong in that information that was given you?

A. It strikes me as a rather low running of it; that is, running it down to a quite small amount.

Q. What was the gravity or quality of the distillate, do you know?

A. I do not have any record as to that. I presume it was a product, which on refining, could be made into merchantable gasoline. That is their business, the making of gasoline.

Q. How does the gravity of the distillate taken off affect the gasoline per hour production in a process of this type?

Mr. Rauber: You mean the refined gasoline or the crude?

Mr. Neave: The crude, the thing that comes off the still.

A. The lower the gravity, that is, the more dense, the larger the rate at which the crude gasoline could distill off. [fol. 424] Q. How does the gravity of the distillate affect the cracking rate?

A. I know of no data on that. I am not familiar with all the factors that affect a Burton still. I cannot become an accomplished Burton still operator in one and a half hour's inspection.

Q. Did you ever make a more thorough or less casual inspection of a cracking process of well petroleums than that which you made at Providence?

A. Yes.

Q. Where?

A. Of the Gartlan process in Ontario.

Q. But that was the one that you did not feel at liberty to tell us the details of, if I remember, is it not?

A. That is correct. I spent about a week up there instead of an hour and a half.

Q. Then there is no other that we can refer to?

A. Yes, the Dubbs' plant outside of Baltimore.

Q. At Providence were the stills fed during the run?

A. I understood not. They were charged and a run was made in, roughly, 48 hours.

Q. Well, it is or is it not, good practice, so far as you know, to feed the stills during the run?

A. The Dubbs process feeds the stills during the run cracking.

Q. What is the effect of feeding the stills during the run; does it make a better process, larger yield, or what?

A. It makes it approach more nearly a continuous process, and we generally look upon continuous processes as more desirable. Of course, you do gradually accumulate carbon, but the attempt in the Dubbs process was to transfer that to the tank and let the carbon accumulate there rather than in the cracking still itself; that is, in the tubes.

Q. In Providence, what was the character of the residue left in the still?

A. It was a heavy oil carrying considerable carbon in suspension and was used as fuel under the stills. There was also some carbon adhering to the tubes and tank.

Q. How much carbon or coke was produced on a run, figured in the percentage of the oil fed?

A. I do not know. I said a moment ago that I was not an experienced operator of Burton stills from only an hour and a half's casual inspection.

The Master: I understand that a so-called continuous operation, where the stills are fed during the operation, is only continuous to a certain extent in that the still has [fol. 425] to be stopped to clean out the carbon after a certain number of hours of operation?

The Witness: That is correct, particularly it is true of a still of the tank type; in the tube types you may get your velocity so that your time is longer, but even in that case the tubes give trouble with carbon formations.

The Master: And the term, "continuous operation" must be taken with that limitation?

The Witness: Yes.

Q. What is the real distinction between a continuous process and a batch process, even when there is some feeding in the batch process?

A. In a batch process the residues would accumulate in the vessel itself, though there might be distillation that would run on for a considerable time, we will say 36 hours.

In a continuous process, the process will run longer, the feed will be approximately the same rate at the end as at the beginning; the distillation will take place in about the same rate at the end as at the beginning, and, in general, the residue will either be removed from the cracking system entirely, transferred to some outside storage tank possibly, or it will be removed to another tank where it can accumulate for a time, until the end of this approximately continuous operation stretch has been completed.

Q. In the operation of the Providence plant as you saw it, how much finished gasoline was produced, figured in percentage of a charge?

A. I do not know.

Q. Do you know how much permanent gas was produced?

A. No.

Q. Have you any idea what those figures should be, that is, for finishing gasoline and permanent gas?

A. I have the general impression that the operation of such a plant would normally give as finished gasoline, a figure which does not agree with the gallonage that I have mentioned here; that is, the amount of 25 or 30 per cent of the charge would come out as refined and finished gasoline.

The Master: Operating on what kind of stock?

The Witness: Almost any kind.

The Master: Operating on crude stock?

The Witness: On a crude stock which has had the gasoline and kerosene taken from it; either on a crude stock, or better still, on a distillate, that is, where the gasoline and kerosene have been removed, and then it has been distilled out to dryness, and the coke remaining back is used as a feed for the cracking still.

[fol. 426] Q. What was the stock that they were using in Providence for their charging stock?

A. A crude carrying about one-half of 1 per cent of sulphur. I was not particularly interested in the subject when I visited it but I inferred that it was a rather low sulphur Mexican oil.

Q. A crude or distillate?

A. The crude was a Mexican crude.

Q. A reduced crude?

A. As I say, I have not a record here as to what the feed was, but the inference that I made was that it was a dewatered crude. It may have been a distillate.

Q. Is the ratio between the gasoline yield and the permanent gas controllable by the refiner?

A. Yes, in the sense that if he wants to he could get pretty near all permanent gas, but he does not want to. He wants to keep it down to a minimum and get as much gasoline as possible. He tries but he cannot control it and get the gas down to zero, but he can get some. He tries to keep it at a minimum but has trouble.

Q. Have you any idea how much permanent gas was produced there in Providence?

A. I answered that question once before, that I did not.

Q. You have no impression about that?

A. No, you cannot, by looking at an iron pipe, tell how much gas is passing through it, an iron pipe.

Q. Well, speaking generally, is there any general rule as to how much permanent gas is produced by processes of this same general character, producing gasoline by pressure distillation?

A. I do not attempt to carry such figures in my mind, any more than I would attempt to carry logarithms in mind. The amount is relatively small in percentages. I have known them, I have seen them, I have a book here that will probably give them, but I do not remember them.

Q. What would I, as an operator, do to control the relation between the gasoline yield and the permanent gas yield in these pressure distillation systems?

A. The first thing to do would be to go to the books which have this data on pressure and temperature and gas yields and look up and see what the figures were. In other words, we use a library.

If I was running such a plant, I would use some of the past knowledge which is written down, rather than attempt to ask somebody's memory on the situation. Then, the next thing I would do, would be to check up on this and possibly we would make a run, make a measurement to [fol. 427] see how near we were coming to the better operating work, as has been done in the past.

Q. How long have the libraries contained these books showing what to do to control the relative proportions of permanent gas and gasoline produced in pressure distillation processes?

A. I find here one statement for 1887, but without pressure, and I will find others with pressure in a moment.

The Master: Is it not sufficient, then, to say that since 1887 those things have been dealt with in books and publications?

The Witness: I think that is sufficient, except I do not recall a definite one as early as that dealing with pressure. There probably were, but I do not recall it.

Q. Do any of these publications tell you what to do so as to vary the proportions of permanent gas and gasoline, or to get any desired proportion that you choose?

A. This one I referred to was one that did just that: It told how to get a nearly 100 per cent gas, and it was 1887 but without pressure.

Q. Now, how, according to those directions, do you get 100 per cent gas?

A. By heating to quite high temperatures in gas retorts. It was an attempt to make gas from petroleum by using high temperatures, and they got not quite one hundred per cent because they got some condensate, benzol and other products. But their ratio of gas to gasoline was probably well over eighty per cent, and possibly as high as ninety-seven per cent.

Q. Is there any commercial process now which is carried on so as to get the maximum quantity of gas from gas oil?

A. Yes, in the carbureting of water gas.

Q. How much gas is obtained under those conditions?

A. All the gas that the gas producer produces, plus the gas which is formed by the cracking of the oil, of the gas

oil, and that, in fact, is the common use, or was the almost exclusive use of gas oil before cracking of petroleum to get gasoline, came in.

Q. And in these processes in which they are trying to get as much gas as they can from the gas oil, what percentage of the oil is converted into gas?

[fol. 428] A. Almost all of it goes off in the form of gas. There is, perhaps, a trace of carbon left there.

Q. Ninety-nine per cent is gas?

A. Omitting any consideration for carbon or a carbon residue, there is not one per cent that does not go off as gas.

Q. That is, in the carburatation of water gas from gas oil, is it?

A. Yes. That does not mean that they cannot, by cooling, get it out again, or part of it; they do, but I answered your question.

Q. How much would they get out again by cooling?

A. That would depend altogether to what extent they had carburetted it and the degree they would cool it as a second step. If they use only a few gallons they would get very little. If they use only a small amount per cubic foot, they would get very little; and if they use a large amount, attempting to make say a high candle power gas, they would get much more.

Q. Now, referring again to what you saw in Providence, what was the character of the gas that was there produced?

A. I did not see the finished product. I did not go through but part, the first part of the refining operation.

Q. Do you know what the character of the gas is that is produced in these pressure cracking operations?

A. It is essentially methane and some hydrogen, some ethane and some ethylene.

Q. Is it the same as gas made by cracking the same type of oil to produce gas as in the Pintsch process?

A. I understand your previous question referred to the permanent gases in cracking for gasoline?

Q. That is right.

A. And in this case, that is, of the Pintsch gas, we are wanting more particularly the gases of high olefine type, and are looking for materials which, in case of gasoline, would be dissolved in the gasoline and sold as gasoline. I am thinking particularly of butylene and propylene as well as propane and butane, but particularly of the olefines,

butylene and propylene, and to a small extent, of amylene.

Q. Then, am I right in understanding that the permanent gas that is given off in these pressure cracking processes is not the same as the gas in the Pintsch process?

A. I would say that in general they are the same; the amounts may vary, but that in the condensation the products which were wanted in gas form in the Pintsch process are dissolved in the gasoline, so that the gasoline will have more of the low boiling constituents. For example, buty- [fol. 429] lene, if present and it can be dissolved in the gasoline, when the condensation is under pressure, would increase the quality of the gasoline by making it easier to start the automobile in cold weather; whereas, in the Pintsch process we do not want the liquid products which are higher boiling and which would condense out as liquids and not evaporate when the cylinder was open.

Q. In such a process as you saw in Providence, to what extent can the operator control the proportions of the constituents boiling up to 212 degrees Fahrenheit, as compared with proportions boiling between 212 to 437? These are the constituents of the finished gasoline that I am talking of.

A. This can only be answered by general knowledge. I did not examine this plant with this in view, but I would say that the use of higher temperatures, meaning as it does an increase in gas production, will probably be accompanied by somewhat of an increase in the low boiling constituents; that is, the proportions boiling below 212 degrees Fahrenheit, but at the same time, would be accompanied by carbon formation and permanent gas losses, both of which are objectionable.

I doubt if the operator to whom I talked would have intelligence enough to carry out a thought along this line.

Q. Do you know how much fuel is used in proportion to the amount of oil charged in the process of pressure distillation to produce gasoline?

A. It would depend entirely upon the process used; one using a heavily cooled dephlegamator would require considerable more fuel than one using no dephlegamator, for example.

Q. Take the process you saw in Providence, that kind of a process; have you any idea what the fuel consumption there would be?

A. I understand that the residue left was somewhat more than ample to serve for the cracking process. This would be, as I say, from the figures given to me, 3,000 gallons for about 13,000 gallons of a charge; 3,000 to 3,500. They had none to sell, they told me.

Q. Do you think that process would be useful in the art and satisfactory if it used that much fuel?

A. I remarked to the party that told me that it looked to me as if they would have some to sell, and he said, "No, we do not have any to sell."

[fol. 430] A. It might be if this much was used, including not only the cracking still itself, but the other requirements of a cracking plant, it would be as I said to him, fairly high.

Q. Does the cracking of the oil itself in these pressure stills absorb any heat? Is there any heat used up chemically there?

A. There are statements made in the literature that it is strongly endothermic (that is heat absorbing). I read that from one of the patents in suit.

Q. What is your opinion of it, Doctor?

A. It is a process absorbing heat.

Q. It is strongly endothermic?

A. No.

Q. Just what is it that you consider it taught by the publications or anything else that you know of, about the process being an endothermic one or exothermic?

A. We have that the heat value per pound is given for, say Mid-Continent crude oil as 19,376, and for a light Mid-Continent oil (that was an average of something over a thousand samples)—and for a light Mid-Continent oil, 19,580; for a heavy one, 19,170; and for a standard or typical fuel oil, 19,175; for a gas oil, 19,635.

We do have the Mexican oils running down about 18,700, and we have, in the case of gasoline and in the case of kerosene, about 20,000. The Navy specifications for kerosene having a heat value of not less than 20,000 B.t.u. per pound. Gasoline is about the same, so that while we have that if the heat values of the starting materials, and the end products are not essentially different, then there will not be, essentially, any great reaction, either exothermic or endothermic in their formation.

If we will take, for example, a material which is formed endothermically, we will have that the heat value of the

product will be greater than of the constituent materials. If it is formed exothermically, the heat value of the product will be less than the materials from which it is formed, per pound.

In this case we have them all essentially between the figures of 19,170 and 20,750. In other words, within a few per cent, one of the other; so that alone, independent of any measurements, would show that the reaction is one in which not any large amounts of heat were absorbed or given off. Of course, in a plant you do have high radiation loss, in a still that is not insulated, and losses of heat like that would account for considerable amounts of fuel, independently of any chemical reactions. There is also the heat lost in the volatilization of the gas; any liquid passing from a liquid [fol. 431] to a gas absorbs heat and in considerable amounts; this amount being what we normally speak of as the latent heat.

Q. Is any kerosene produced in a cracking operation such as that you saw in Providence?

A. I know of no cracking operation which does not produce kerosene simultaneously with the production of gasoline.

Q. How much kerosene was produced in that operation at Providence?

A. I do not know.

Q. How much is produced in an operation of that character?

A. Sometimes less than what is wanted. For example, the Dewar & Redwood plant was started in Russia and was given up because they got too much gasoline and they wanted kerosene.

In other words, the Dewar & Redwood plant on the Russian oil was a failure because it produced gasoline rather than kerosene.

Q. Upon what is your information based that the Dewar & Redwood process was set up for operation in Russia?

A. It is fairly generally known, but as I recall, the last place, I saw it was in Day's Handbook of the Petroleum Industry.

Q. That is the only place you found that?

A. No, I had heard it before and I looked for it there and found it.

Q. Did you ever make any inquiries from Professor Dewar or Professor Redwood in that connection?

A. No, Dewar, I think, is dead, and I do not know about Redwood. Redwood, I think, is dead also, and I am not a spiritualist.

Q. When was this thing set up in Russia, as far as you know?

A. How is that?

Q. When was this set up in Russia, as far as you know?

A. I do not know, for I have not had occasion to inquire about it until the last month and a half.

Q. Dewar and Redwood were both alive until the last year, were they not?

A. Yes, but my interest in this only arose since this case, August 14th, when my connection began officially with this case. I have here the Day Handbook, if you want me to read the citation.

Q. You need not read it unless you want to, if you will just give it to me I will look it up.

The Master: They can look it up.

[fol. 432] The Witness: All right.

The Master: Doctor, suppose that in the operation of a plant, the operator found too large a proportion of these low boiling point fractions being converted into permanent gas, what would he do to stop it; what would he do to his apparatus?

The Witness: It would likely be caused by either of two things: One, that he was operating, at too high a temperature, or, on the other hand, that carbon had started in quite large amounts and was catalyzing the decomposition.

In the first case, he would lower his temperature, and in the second place, he would clean his still.

The Master: Would he increase his pressure?

The Witness: Yes, increase of pressure would help.

Q. Will you let me have that reference to the Day book?

A. The reference is "Day, a Handbook of the Petroleum Industry," page 428, Volume 2. (Reading):

"The last named patent covered a process conducted in a still under pressure and designed for the production of lamp oils or kerosene. The experiments were made in Rus-

sia, and due to the production of comparatively large quantities of gasoline, which was practically unsalable at that time, the process was abandoned."

Q. Now, referring again to those operations that you saw in Providence, I gather that you consider that there was some kerosene produced. Where did it come from, was it in the distillate or in the tar, or where?

A. It would come from the cracking of the oil, the oil fed to the still.

Q. And where was the kerosene taken off?

A. I do not know whether it was taken off, they may have cracked the kerosene as well, but I think it was taken off as a part along with the gasoline, but as I told you a moment ago, I did not see the refining of the gasoline, [fol. 433] excepting just one step of it. They may have made a separation of gasoline and kerosene constituents afterwards by distillation. That would be my expectation.

Q. You did not see them make any separation?

A. No, I did not. I did not see the refining plant excepting just one step of it.

Q. Now, if there was some kerosene made there, what was its character and how did it compare with the kerosene made by cracking at atmospheric pressure?

A. As I said, I was not there, but answering your hypothetical question, I would expect that it would be essentially of the same character as kerosene made by atmospheric cracking, if made by cracking under pressure.

Q. Leaving aside the Providence plant, have you any experience with other pressure cracking processes operating upon crude oil or a distillate crude oil, from which you could determine what the character of the kerosene was that was gotten off, and how it compared with the kerosene produced by cracking at atmospheric pressure?

The Master: How can he compare something that he does not know anything about?

Mr. Neave: You see, he does not know it in Providence, and I was wanting to see whether he knew it anywhere. If he does not know anything about it that will foreshorten it.

Mr. Rauber: By "experience," do you mean the prior art, too?

Mr. Neave: Any experience, yes.

A. In the Gartlan plant in Ontario, the product made, carried both gasoline and kerosene and some higher products, and on distillation and running it through a laboratory refining, if a product made under pressure cracking, carried about 45 per cent unsaturates, as determined by sulphuric acid test, this would be not essentially different, apparently, from what the disclosure of the printed prior art have shown in the way of atmospheric pressure cracked burning oil, and it would not disagree, particularly, with the data given in Allen's Commercial Organic Analysis of 1910, on page 110.

Q. You have spoken of a visit that you made to a Dubbs' plant. That was an inspection occupying about an hour, was it not, and a great many people going through the plant itself?

A. No, in that case I spent about three hours, or three hours and a half, in the case of the Dubbs' plant. In the Providence plant——

Q. Was Mr. Wilson with you at that inspection of the Dubbs' plant?

A. I don't know. In the case of the Providence plant I was there only for about an hour and a half as I had to catch a boat and left before the crowd did.

Q. When was it that you saw the Dubbs' plant?

A. It was in April of this year and I stayed beyond the time while the rest of the crowd was there, with the superintendent, for perhaps three-quarters of an hour. If Mr. Wilson can tell me how long the crowd stayed, add three-quarters of an hour to it and you will have the time I stayed.

Q. This was a meeting of the American Chemical Society?

A. Yes.

[fol. 434] Cross-examination.

By Mr. Wiles:

Q. Doctor McKee, in connection with your testimony as to the Burton patent, No. 1,167,884, the product patent, which, by the way, I shall frequently, perhaps, refer to as the twine oil patent, on account of its being recommended for that use, on page 2——

A. What kind of patent?

Q. I usually call that the twine oil patent, because it has that particular use for it recommended on page 2.

The Master: What is twine oil?

Mr. Wiles: Binder twine oil. I have usually referred to it in my own mind as the twine oil patent, and it is a good short name for it.

Q. In connection with that patent, you made a very considerable number of calculations. Have you those calculations in such form that you can hand them to use and they will be self-explanatory, so that we can study them outside of the courtroom, just to save time?

A. I do not recall just which of these I gave you. I made a good many calculations; in fact, I have the results here on three pages of typewriting, but I only gave in my testimony probably one-twentieth of them, so that I cannot, from memory tell which ones of those I gave. If you can give me the page references, probably I can get those for you.

Q. On page 370, printed record. Now, did you give in this record any specific example from the prior art, prior to the one that starts at the bottom of page 370 with reference to the Riebeck patent?

A. Yes, I did, from the Burton patent on page 369, which are just as important, of course.

Q. Yes. You mean the prior art examples from the Burton patent?

A. Yes.

Q. But this Riebeck one was the first of the patents, or other art, other than the Burton patent, is that correct?

A. It is the first I gave.

Q. Now, have you the data of the calculation, the results of which appear at the top of page 371, so that we can check them without going through them here in court in detail?

A. I think I can give you that data so that you can. That is, I cannot give you my additions and multiplications, but only the results and the data from which you can, by means of a slide rule, carry it out.

[fol. 435] Q. I want to get all of these that you gave in your direct, and I want to be sure that we are together on just how many there are. First, there is one on the Riebeck——

The Master: That is on page 370, last paragraph.

The Witness: And 371, yes.

The Master: Then there is the Burton.

The Witness: Burton, on page 369.

The Master: And also at the bottom there—at the bottom of page 370 and running over on page 371.

The Witness: Then Engler and Singer.

Q. The next one is this Engler and Singer on page 371, is it?

The Master: Yes. Then, Aisinman.

The Witness: In the Engler and Singer I could not make the calculations because no specific gravities were given, so there are no calculations and none were quoted; but the Aisinman——

Q. The next one you did calculate was the Aisinman, which is mentioned at the bottom of page 371 of the printed record, is it not?

A. Yes.

Q. And those were the only two examples that you gave in your testimony in direct, were they not?

A. No, I gave two others. I gave from the Burton patent itself, in which the variations were given there for a Kansas oil, I think it is, and which he said filled the conditions. I refer to page 2, of Column 1——

Q. I had in mind the prior art.

A. (continued). And also I showed the general character of the Engler and Singer, but it did not have the specific gravity given.

Q. So you could not tell anything about that, whether it really filled the conditions or not?

A. I might have given as prior art——

Q. No, I did not ask you what you might have given, I am asking you what you did give in your direct. Of the prior art, the only ones that you gave and applied to the equation were the two, the Riebeck and the Aisinman; that is correct, is it not?

A. That is correct.

Q. Well, now, I want your data on those two.

A. You would dislike to have the data as given by Burton, and which I quoted here?

[fol. 436] Q. I am perfectly willing to see them, but it is not what I am particularly interested in. I will be very glad to go over it.

Now, at the noon hour will do, just as well, Dr. McKee, for you to get that ready.

Perhaps at this time, though, I would like to see the form it is in to see whether any preliminary questions are necessary.

A. (indicating.) Here is the Burton with the discrepancies; specific gravity transformed to Baume, Engler viscosity transformed to Saybolt with discrepancies; Aisinman's specific gravity, Engler Baume, according to Battle; according to Bureau of Standard's method. I only quoted a part of this. I will not give you all of these calculations; (indicating).

Q. Now, having glanced just briefly at your data, I want to ask you one or two questions which will help us in going over them. In the first place, I want to direct your attention to the top of page 371, printed record: The figure 10.73 is an error, is it not; in the fourth line, and also in the first line?

A. Possibly it is. I do not know, if it is; it is an error in my calculations.

Q. Now, is it not a Reporter's error? Did you not mean to say 17.3?

A. I have it down. If it is an error, it is an error in my original typing on that, because I have it in my typing here as 10.3.

The Master: 10.73?

The Witness: 10.73.

The Master: It might be an error in typing?

The Witness: Yes, it might be an error in typing.

The Master: Have you got your work sheets?

The Witness: I haven't them here. I have them up to my office.

The Master: Look at them and make the correction, if it is an error.

The Witness: Yes.

Q. Will you just refer to your Baume table and tell us.

A. That should be 17.3 or .95 specific gravity; .95 would correspond to 17.3.

The Master: 17.19?
The Witness: 17.3.

Q. And are you able to tell from the data you have here [fol. 437] whether you used the right figure or the wrong one in your calculation.

A. I am not able to tell, because it has been a month ago since this was done. Memory would not permit me to state.

Q. Now, when you made your Baume (and I have noticed you have done this several times in translating from specific gravity to Baume) why did you not use the Baume scale commonly used in the oil industry, which is now called the A. P. I.?

A. As I recall on this what I did was to use, I think, the Bureau of Standards on that scale.

Q. Well, did you use the Bureau of Standard's Baume, or the Bureau of Standards' A. P. I.?

A. I tried to use, as recall on this a Baume that was used in 1915, and I think there was no A. P. I. at that time. I am not certain about that; in fact, I am not even at this instant absolutely certain just which scheme I used. As I said a moment ago, this was done——

Q. Is this not the fact about these two different scales: That for a long time the petroleum industry used a so-called Baume scale that was not exactly the same as the regular Baume scale, and when the Bureau of Standards first attempted to standardize, they found that there were, in the oil industry, these different Baume hydrometers from the usual ones, and therefore, they adopted two scales; is that not the fact?

A. I do not recall that the Bureau of Standards adopted a second scale. It is possible that they did. I know that the petroleum industry adopted a second scale different from the standard Baume scale. I am not questioning your word, but as to the adoption of a second scale, I thought it was a question of the petroleum industry.

Q. I will ask you to read—you accept the Lefax Engineers' sheet as standard probably on matters of this kind, I presume, do you not, Doctor?

A. I would not call that particularly a standard, but they are generally——

Q. Generally accepted?

A. (continued). —quoting standards.

Q. Now, will you just read through the first three paragraphs of Lefax's sheet, No. 13,272, and see whether that does not check with my statement?

A. This checks with your statement.

Q. And this A. P. I. scale as it is today called, and is to-[fol. 438] day agreed upon by the American Petroleum Institute, The Bureau of Mines and the Bureau of Standards, is the same identical scale, which has long been in use in the American Petroleum industry under the name of Baume?

A. I should judge from reading the Lefax, that that is not quite true; that they had variations but there were several scales in use, but that this was a compromise figure.

Q. Did that not represent most closely the common standards of the oil industry?

A. Yes, but it was not the exclusive standard.

Q. And when a man, in 1915, in the oil industry, used Baume figures, he would naturally mean the figures of this present A. P. I. scale?

A. No, he would mean the figures of the then Baume scale used, which is approximately, though not exactly, this present A. P. I. scale.

Q. But it is much closer to the present-day A. P. I. scale than to the other one, than to the old Baume scale?

The Master: It was not what a man had in his mind, it was what the art would understand from the reading of his patent.

Q. Well, is it not a fact that——

The Master: And not what would the man understand he meant.

Q. (Continued:) —in the petroleum industry, men skilled in the art in that day, reading a statement from an oil man as to Baume gravity, would understand approximately the present A. P. I. figures?

A. Yes, approximately, I think so; but not exactly.

Q. And that is the best method of translation that you can get today?

A. Yes, a present method.

Q. So that in translating, for purposes of comparison with this patent of Burton's Engler or Aisinman's figures, to compare them with the figures Burton was talking about,

you should translate in accordance with the A. P. I. scale, should you not?

A. The actual figures are practical by identical; for example, 93/100th——

Q. Just a minute, Doctor. I did not ask you that. I asked you which table you should compare with; will you answer that question?

A. We should compare with the American Petroleum Institute, but the figures are identical for .93. It make no [fol. 439] difference, because .93 comes out 20.05 in one case for Baume, and in the other case it comes out 20.06, one part in 2/1000ths; whereas, the original figures are correct, .93, only through the second decimal place instead of the fourth decimal place.

Q. Now, just check that figure that you last gave, and which you volunteered and see how much you want to modify it?

A. .93, according to the book, No. 15, giving the United States Bureau of Standards tables, would be 20.——

Q. 20.6, is it not?

A. It looks like this is again——

Q. 20.5?

A. One is five and the other six. It looks as if this was again an error in the typing; it is 20.65, 20.5.

Q. 20.65, is the exact figure, is it not?

A. Yes, in one case.

Q. And not 20.05?

A. And in the other case it is 20.56.

Q. Then your testimony was in error when you said 20.05, was it, too?

A. I think so, if these tables are correct. With specific gravity tables, we will have to take and look at these larger tables, which is what I think were used, as I have both a reference to a Bureau of Standards' table, which I presume is——

Q. Then the actual translation of the .930 specific, gives about a half point or more lighter oil than you stated in your testimony?

A. There is no .930 here; there is a nine three.

Q. Your testimony gives it .930, does it not, at the bottom of page 370?

A. Yes, it does.

Q. Now, the correct translation of that .930 that you gave in your direct testimony, into Baume figures, is about a half a point lighter than you stated, is it not?

A. It is.

Q. And that, of course, is in a direction away from the Burton patent?

A. It happens to be that it is. It happens to be that——

Q. That is all I asked. It is?

A. That these figures, when we figure from that (indicating) are quite a distance away, anyway.

Q. And the other error, which may be a misprint, is 7 points away.

A. Which may be a misprint?

[fol. 440] Mr. Rauber: What do you mean by "7 points"?

Mr. Wiles: Seven points on the Baume.

The Witness: No.

Mr. Rauber: Seven degrees?

The Witness: It is 7/10ths of a point, but it may be 7 degrees.

Q. Seven degrees Baume' off.

A. It may be.

Q. And the correct translation of the .930 specific is 17.45 Baume', is it not?

A. 17.45 degrees Baume'.

Q. Your error there also is in a direction to bring it apparently closer to the Burton patent in question, is it not?

A. If it was an error in calculations, we will have to calculate it out. That may be simply an error in copying, in typing.

Q. Well, it is in that direction, is it not?

A. If it was an error——

Q. The direction of that error is such as to bring the oil apparently closer to the Burton patent, is it not?

A. If that was an error in calculation, I think it is; if it is an error in typing it would, of course, not affect it.

Q. Now, in the paper which I just had time to glance at, you gave merely the results of your translation of the Engler viscosity into Saybolt viscosity. Just tell us exactly how you performed that translation; your method does not show on the paper.

A. Your statement of what I have said in the paper is not correct. I did not transform that into Saybolt's viscosity, according to my——

Q. I have reference to the matter at the bottom of page 370 of the printed record, where you translated——

A. That is Riebeck and not Engler.

Q. That is Engler's viscosity, is it not?

A. Oh, I misunderstood you. I thought you were after the Engler and Singer article.

Q. No, no; how you translated Engler viscosity into Saybolt viscosity.

A. The Bureau of Standards, Technology Paper No. 112, of 1919, gives, in Table 9, on page 21, the equivalent of viscosities.

Q. Have you that table here?

A. I possibly may have. There is also, in Battle's "Lu- [fol. 441] bricating Engineer's Handbook of 1916," a similar table, though the two do not agree entirely. That is one of the tables for it.

Q. Now, based on this table in the Bureau of Standards Bulletin No. 112, page 21, you translated 7 Engler as 239 Saybolt, is that correct?

A. Yes. I think that this was from this table, though it may have been, as I said, from Battle's "Lubricating Engineer's Handbook of 1916," which also gives a table of transformation. I think, though, that this was from the Engler.

Q. From the Bureau of Standards Bulletin?

A. From the Bureau of Standards Bulletin No. 112.

Q. You consider the Bureau of Standards to be the most reliable on the subject, do you not?

A. Yes. It is later and probably is more reliable.

Q. And you similarly translated 10 Engler as 342 Saybolt?

A. That is correct.

Q. And that was done by approximate interlopation in this table?

A. Yes.

Q. On page 368, printed record, in answer to the question:

"Q. What relation does the viscosity have to the specific gravity in hydrocarbons of the same series?"

You answered:

"A. Generally, the higher the specific gravity, the higher the viscosity."

Is that not always true, not merely generally, so far as you know? If it is not, I want you to give such specific examples as you know of which contradict that rule.

A. I do not recall any case of a hydrocarbon in which that is not true, though I know of other materials of which that is not true. The statement I made most generally, is still true, of course.

[fol. 442] Q. Do you find anything in the Kittle patent with reference to the function of the chamber, F, other than the patent calls it "a separating chamber"; also calls it "a separater" on page 4 of the translation?

I understand my translation is not paged like yours, so I can not tell you where it is.

A. I see.

This patent is an apparatus patent and not a process patent, and as such it is not, in general, discussing functions at all. It is primarily, and I think almost exclusively, concerned with construction details, rather than with operation or function.

Q. Do you find, Dr. McKee, anything other than the matter which I referred to, as to the function of this chamber?

A. I find no mention of function. I do find that it speaks of it as a piece of apparatus, as a chamber of separation, F. I am reading now from the French, page 2, line 49. And in the next paragraph, page 2, line 56, that "this separator is connected to three pipes," no discussion as to its function.

Q. Now, what is it that this chamber is to separate?

A. From this chamber pass off three pipes, one carrying vapors which are passed to the condenser; one carrying vapors which may be passed to another condenser, or may be burned; a third carrying liquid, which has remained in the chamber for a time, and taking it away to another vessel.

Q. You mean, then, that the chamber is to separate the liquor from the vapor?

A. And vapor from vapor—if you want that, also.

Q. What do you mean by vapor from vapor?

A. The one going to the condenser to be condensed in condenser, G, of the figure, and the other vapor pipe going through the valve, F 3, and F4, down to the heating pipes and flames, connected with H.

Q. That separation is not in kind—it simply takes two streams of vapor, the two to be condensed—does it not—vapor of exactly the same kind?

A. I think that is correct.

Q. So that the purpose of this chamber is to separate liquor from vapor?

[fol. 443] A. It is for more than that.

Q. And to give you a header for different vapor outlets?

A. And more than that.

Q. And what else does it separate?

A. It is for more than that—it is for more than separation.

Q. You mean, you think it does more than merely separate?

A. I certainly do think it does.

Q. But the disclosed purpose of it is merely to separate?

A. No. The purpose of it is not disclosed. The apparatus was given as an apparatus—it is an apparatus patent, and not a process, or function patent.

Q. The stated purpose is to separate liquid from vapor, isn't it?

A. No, it doesn't mention any question of separation of liquid from vapor.

Q. Well, since it is to separate something, the only separation that there is, is that between liquid and vapor—isn't that a fair statement of the stated purpose of this chamber?

A. He gives the chamber a number, F, and describes it and names one of its uses—the only one as being enough to designate it—and I don't think it is a fair statement to say that that is—as you have inferred—the only use of that chamber.

Q. I didn't say that, Dr. McKee—I said the only stated purpose—I am leaving the other question for the future.

A. It doesn't state that that is the purpose.

Q. It says "separating", does it not?

A. It does, and it shows pipes, which I have read into it as separating liquid from gases. The patent doesn't say that it separates liquid from gases.

Q. Well, that is the only thing it could separate, isn't it?

A. I don't find it indicated, but it would be just as fair an inference to include solids and carbons—so that it would be more than liquids that would be separated—that is, the coke and the carbon deposited by the cracking process, would need to be separated, as well.

Q. Then, this is the fact, is it not, that the only disclosed, or stated purpose of this chamber, F, is the separation of vapors on the one hand, from liquids, and possibly solids, on the other.

Mr. Rauber: Do you mean stated in so many words, or by inference?

[fol. 444] Mr. Wiles: Yes, exactly—I will come to the interferences in a little bit.

A. It is not so stated.

Q. Does it state anynthing else?

A. Yes, a good many things. It describes—

Q. As to that chamber—as to the chamber F.

A. It simply—It states that this vessel, F, is immersed in moulten metal, contained in a reservoir, E, and then it says it is connected to three conduits, F, F^1 and F_2. Those, I think, are all that he states—no, there is one more.

One part of the oil vapor can be brought form the separating chamber, F, through the regulating valves, F 3, and F 4, to the burner, H, and placed in a manner to heat the metallic bath contained in the reservoir, E.

I think those are the only three places that F is mentioned as a construction phase.

Q. Now, as to the function—the only statement of function is separation, isn't it?

A. It calls it a separating chamber, and I don't feel that it is a fair statement regarding this, to speak of it as if that was the only function of it.

Q. I didn't ask you that, and I just want a square answer to what I am trying to get at. Is that the only stated function? I know you think there is another function, and I am coming to that later, but is there any other stated function than separation?

A. It doesn't state that it is. It is not a function statement at all. It is an apparatus, or a construction statement

that is given in the patent. This is an apparatus patent, and not a process patent.

Q. Do you mean to say that these statements that this is a separating chamber is not a statement of function?

Mr. Rauber: Was it your intention to say that that was a descriptive statement?

The Witness: It is descriptive of apparatus, and only indirectly as to one of the uses of it.

Q. You have stated repeatedly that this is a mere apparatus patent. Isn't the first claim in the French patent a process claim—also the second claim?

A. The patent has claims both for process and for apparatus.

Q. And the first two of the three claims are process claims, are they not?

Mr. Rauber: You are not asking him to interpret those claims, are you?

Mr. Wiles: No. I am asking him to state whether they are process or apparatus claims.

Mr. Rauber: As described therein?

Mr. Wiles: Yes.

A. Yes.

Q. And in the last sentence of the specification, reference [fol. 445] is made to different methods of carrying out the invention, which has been described above—that is the fact, isn't it?

A. Yes.

Q. Now, assuming that all you want to do in a chamber of this character, is to separate vapors on the one hand, from liquids and solids, on the other hand, how much time do the materials to be separated, have to remain in that chamber, in order to accomplish the separation?

A. I think I can give that answer better by making comparisons, because, in the first place, I do not know the exact speeds, or the exact dimensions in feet, or inches, or centimeters, as here.

The time would not be long, but the chamber, for example, is larger, relative to the heating coils from, for example, in the Ellis patent, of the tube and tank type.

The Master: You mean it is larger on the diagram?

The Witness: It is larger on the diagram, in capacity, as judged from the diagram in the case of the Ellis tube and tank type.

The Master: There being no statement of proportion in the patent?

The Witness: In either patent.

Q. Now, the separation of gases, or vapors on the one hand, from suspended liquids and solids, on the other, is a very common problem that is met with in all sorts of chemical engineering, is it not?

A. Yes.

Q. And to accomplish that purpose but a brief time is required, providing the velocity is materially slowed—is that a fact?

The Master: You mean the velocity of what is slow?

Mr. Wiles: The stream.

Mr. Rauber: Have you reference to any certain apparatus? Do you mean in a cyclone separater?

Mr. Wiles: I don't mean a cyclone separater. I mean the ordinary separater.

A. Do you mean a period that is brief in the apparatus built for the purpose?

Q. Well, in a mere chamber—such, for example, as that illustrated in this Kittle patent. You don't need a long time to drop liquids and solids out of a gas stream, do you?

A. Not with ordinary materials. With some materials, for example, sulphuric acid, you need a very long time, and it is exceedingly difficult to do it.

[fol. 446] Q. But that is a problem that is constantly met with in the oil industry, is it not? I don't mean sulphuric acid, particularly.

A. I would say that it is met with in most industries of a chemical character.

Q. And in handling oils no material time is required to drop the liquid that forms out of a stream of mixed vapors liquids from solids.

A. I would say that it was a material time, because we do have foaming effects, and spray effects, which must be permitted to setle there. It is certainly a material time.

Q. A minute or two will do it, won't it?

A. Yes, I should say, in general, it would. It depends, of course, upon the apparatus used.

Q. And the time required to effect a mere physical separation from the stream of vapors, of the liquids and solids that it may carry, need not necessarily be long enough to permit any chemical changes, at all, of appreciable magnitude—that is the fact, isn't it?

A. Yes—just a moment—I doubt it, for in such a case as this, of the one we have had under discussion—Kittle—there will be changes occur in the liquid passing through the coil, and yet we have a vessel large enough to have a larger capacity than the coil itself. Consequently, being at the same temperature, it would have ample time for chemical changes—more time even, probably, than it had in the coil.

Q. Now, what I want to get at is this: If your object is mere physical separation, may not the time be so short that the chemical changes during the time of separation, will be negligible?

A. You said a moment ago, say a period of one or two minutes. I would say that in oils at a cracking temperature, two minutes is a very considerable time, to accomplish cracking, and in many cases of cracking work, the oil is exposed in the hot vessel, or in the hot tube, to less than two minutes time, and yet a cracking of, perhaps, all that is wanted, occurs in that period of two minutes time, and we would then have that two minutes time as a long time for cracking time.

Q. Now, what commercial cracking process is there for the manufacture of gasoline, or motor spirit, where any such a short time as that is employed?

A. I think, for example, of the Greenstreet process as a process in which less time than that is used in the exposure to the high temperatures, and that is one which, you may [fol. 447] recall, has been considered very seriously as a scheme for adding light ends to the cracked material obtained by the Burton process.

Q. The Greenstreet process was promoted, to a certain extent, in this country, was it not?

A. I don't know how much promotion it was——

Q. The Greenstreet process has entirely gone out of commercial use, has it not?

A. I don't know—I think so. But it has been used for the making of——

Q. And it failed commercially, did it not?

A. No, it did not, as I understand it. It failed because of a different commercial situation arising, due to the coming in of larger amounts of casing-head gasoline, as a competitor, so as to furnish the light ends for adding to cracked gasoline, made, say by the so-called Burton process.

Q. Well, whatever the reason is—it has gone out of business?

A. Possibly, I don't know. If you say it has, I will accept that statement.

Q. Do you know of any commercially successful cracking process for the manufacture of motor fuel, where the cracking time is anywhere near the cracking time that you have stated here, in the order of a minute or two?

A. There is a process in commercial use, which has the oil exposed to the heating medium for less than two minutes—considerably less. I refer to the Dubbs process. It does pass to a tank and holds its heat, to some extent, afterwards, but during the process, in which it is being exposed to the heat—to the heated walls of the cracking vessel, it is exposed to a considerable less time, I think, than two minutes.

Q. How long is it held, in the process, in the tank, at a high cracking temperature?

A. Somewhat more than, perhaps, two minutes, but I don't——

[fol. 448] Q. Two hours, isn't it?

A. I don't know.

Q. Well, it may be, so far as you know?

A. If you say it was two hours, I——

The Master: If the witness says he doesn't know, that is the end of it.

The Witness: But it is exposed to the heating vessel, in the heated vessel, for less than two minutes—which was your real question, as I recall.

Q. My question was, what commercial process—and I will ask you again, if you know of any commercial process, for the manufacture of gasoline, or motor fuel, where the oil is held at a cracking temperature for anything like two minutes, or anything approximating that figure.

The Master: Do you mean only two minutes?

Mr. Wiles: As little as only two minutes.

A. Yes, sir. The process described in Nikiforoff's United States patent, No. 755,309, has been used in Russia, and has been used in commercial work for a considerable time, manufacturing a cracked process gasoline from the Russian oil. It is only using a pressure of fifteen pounds to the square inch and cracks at a temperature of around 50 degrees Centigrade. It collects, separately, the product, and the product distills below 200 degrees, is then re-cracked to get benzol and toluol, and such.

I could give you a citation showing that this was carried out, and used in quite a good sized commercial plant.

Q. Is that the only one you have in mind?

A. I am thinking of one at a time. Greenstreet was one that I mentioned. And the Dubbs' process heats the tubes, and it is in the tubes for less than two minutes. The Nikiforoff process, described in the United States patent, and also in use in Russia in the making of a good many hundred thousand pounds of product——

[fol. 449] Q. Now, again referring to this Kittle patent—the dimensions of the apparatus, at Fig. 1, are given in the patent, aren't they?

A. I find certain of the dimensions given on page 2, line 76. There are a few of the dimensions given there.

Q. It is apparent, isn't it, from the way these dimensions are given, that they are translations from the French, of the Metric system of English measurements, inches and feet and pounds—just translated into the Metric system?

A. I think that is correct. Kittle was an Englishman, apparently.

Q. And the dimensions of the pipe that makes up the coil, D, are an eighth of an inch by twenty feet, aren't they?

A. The twenty feet is right, but the eighth of an inch, I don't think is correct. I think it is a three-eighths inch pipe, whose internal diameter would, then, be, perhaps between a fifth and a sixth.

Mr. Rauber: Perhaps you had better calculate that.

The Witness: Nineteen one-hundredths of an inch, would be the exact figure.

Q. Now, the drawing shows this twenty foot pipe as coiled into a helix, with eight turns, doesn't it?

A. Yes.

Q. So that those would be about two and a half feet each in circumference, and the whole business would be about nine inches in diameter—isn't that true?

The Master: How often have you heard the Court remark that the object of reading patent drawings, or patents, is to make them work, rather than to make them not work?

Mr. Wiles: I think this would work for what it is stated—and that is what I am trying to bring out.

A. Yes, nine and a fraction inches.

Q. And then the little separating chamber, F, would be about four inches in diameter, and about five inches high?

A. As I scale it off, it is four by six.

Q. And the speed of oil through this little apparatus is eight gallons an hour, isn't it—about?

A. Approximately so.

Q. Now, if this drum were entirely filled with liquid—that is, if there were no cracking, at all, and if the liquid just flowed through the drum, the time in the little drum would be only about two and a half minutes, would it not?

A. The time of what?

[fol. 450] Q. The time that the liquid would be in there—at eight gallons an hour.

A. That would be correct, for this model apparatus.

Q. Now, you just referred to this as a model apparatus—one of the suggested uses of this apparatus is to put it on a motor car, is it not, and regulate your gas and use it on your car—isn't that true?

A. Yes.

Q. And for that purpose an apparatus that will handle eight gallons of oil is a preety good size apparatus, and will handle almost any car, won't it?

A. If it yields only the customary amount of gasoline, roughly, say 25 per cent, which would mean two gallons an hour—and there is many a car that will use more than two gallons of gasoline an hour.

Q. But this apparatus might be of a perfectly proper size for a car, might it not?

A. Yes.

The Master: You mean as shown in the drawing?

Mr. Wiles: As shown and described, by dimensions.

Q. Now, if the little drum, F, were filled with vapor at atmospheric pressure, instead of with liquid, the time the vapor would be in there would be only a second or two, wouldn't it?

A. That is correct, on the supposition that you gave.

Q. And any reasonable pressure could not increase the time that the material is in the drum, more than a few seconds?

A. I think that is correct.

Q. And this very brief exposure would be sufficient to separate the liquids and solids from the stream, wouldn't it?

A. What brief exposure do you mean? What do you mean by "brief exposure"?

Q. Oh, a few seconds.

A. I would expect that we would have to have—in order to separate spray from such a liquid—a time measured in a real number of seconds.

Q. Now, I notice in this Kittle patent, the following:

"With the object of insuring conversion of the hydrocarbons into more volatile hydrocarbons, the oil is maintained at a high pressure, while passing through the apparatus. This is accomplished by preserving, or providing some pressure at the discharge end, either by sufficiently closing the escape hole, as illustrated in Figures 2, 3 and 4, or else by keeping the column of oil above the outlet opening, as depicted in Fig. 1."

[fol. 451] My translation, I understand, is slightly different from yours, but is that approximately what your translation says?

A. My translation is quite different in that last line, but if you will bear with me a moment, I will look at the French and see which is correct.

Q. This is line 75, page 3, I believe. I am not much of a Frenchman, myself.

A. That, I think, should be below—as my translation has it—below the escape orifice. The meaning, however, I think, is essentially the same. It should be below, instead of above. I would say the two mean the same.

Q. That is, there are, then, in patent, two different methods of maintaining pressure, and the one in Fig. 1 consists in keeping the oil head on the outlet—that is right, isn't it?

A. That is one method given.

Q. And that is the one given in Fig. 1, and shown in Fig. 1?

A. Yes, sir, but modified, of course, by the text which you have read.

Q. Now, in figures 2, 3 and 4, where the alternate methods of pressure maintenance is given, there is no drum, corresponding to the drum, F, is there?

The Master: You mean the drum is not shown on that figure?

Mr. Wiles: Yes. It is left out entirely. It is a complete system without it.

A. In Fig. 4, you have its equivalent. You have here, in Fig. 4, a space above the level of the metal, which is used for the same purpose, and you have a space below. Reading from the translation:

"In causing this apparatus to function, the oil is placed in circulation through the worm, R_2, and is discharged hot, through the venting orifice, S, under the perforated baffle, S'. The oil rises upwardly through the mass of moulten metal, and is thus vaporized. The vapor passes through the baffle plate, T 4, through the perforation, T_2, into the conduit, T', and from there into the worm, V."

I would understand that the space above the metal—the moulten metal—before reaching the baffle plate, T 4, is used in the same sense as the chamber, F, in figure 1.

Q. Now, referring to Fig. 1, where this oil head method of maintaining pressure, is employed, if you follow the pro- [fol. 452] portions given in the drawing, the pressure cannot exceed over a few ounces, can it?

A. No, but he definitely states that it is 6.45 pressure there, which practically means the equivalent of six and a half atmospheres.

Q. A hundred, or ninety-five pounds to the square inch, isn't it?

A. Something like that.

Q. Now, the pressure that you have just mentioned, about a hundred pounds to the square inch—is the pressure on the feed oil at the top, isn't it?

A. It is, but I would understand that it was also on the oil at the cracking coil. I don't recall a single case where we

ever make our pressure on the cracking oil, without putting it equally on the feeding oil.

Q. Isn't it a very common expedient, when you want to feed a liquid, through a valve, and be able to supply as much as you want, to put the supply tank under considerable pressure, so as to be able to force it out of the valve, and possibly spray it?

A. Such a scheme is used when we wish to spray a liquid, but here it is hardly to be thought of, that they want to spray inside of a pipe, that is only, perhaps a sixth of an inch in diameter, internally.

Q. Now, in ordinary, common gasoline torches, we put a considerable pressure on top of the gasoline, do we not, and blow it right out?

A. Yes, but it is not used to spray the inside of a quarter inch pipe, or three-eighths inch pipe.

Q. It is about a half inch pipe there, isn't it,—in the common plumber's torch.

A. If I am remembering the same apparatus as you are, I would say it is not spraying the inside of any pipe. Coming to the common plumber's torch, it is spraying gasoline out, but it is spraying out through a pipe into the air.

Q. Exactly, and——

A. And this is not doing that. This is running the oil into a small pipe, the size of a lead pencil, roughly.

Q. And if you want to keep your oil moving, and this pipe should carbonize inside—as it very well might—this hundred pounds back of it to drive it in, would help a good deal, wouldn't it?

A. The carbon formation would easily stop a hundred [fol. 453] pounds pressure almost as easily as it would a five pounds pressure.

Q. But you could keep running a good deal longer with a hundred pounds back of your oil, than you could with a very minor pressure—isn't that true?

A. Not much longer than you would with five pounds.

Q. Well, it is the fact, anyway, isn't it, that a hundred pounds is described as on the feed oil, up at the upper part of the apparatus?

A. That is correct,—that is true, of course, in general of most feeding apparatus, for cracking processes. That is, the pressure is applied to the feed oil, as is the habit in practically all cracking processes.

Q. And there is a value to control that oil—the valve A-1, by which the oil can be introduced into the coil, D, at any pressure you want—isn't it?

A. No. You could not, for example, get a pressure of a hundred and fifty pounds.

Q. Well, any pressure below a hundred?

A. You could not get a vacuum by it. Practically speaking, it controls the rate of feed, rather than the pressure. It is not a valve of the type which one would think of as an automatic regulation of pressure, or anything of that kind.

Q. Oh, no—it is a hand operating valve. Now, with that valve, and controlling it anyway you please, you could have a pressure in that apparatus, anything you choose—from a few ounces up to a hundred pounds, couldn't you?

A. You could, if you did away with your column of liquid below. Of course, from the paragraph that you have read, the oil being maintained at a high pressure while it passes through the apparatus, would not apply in such a case as that—that is, the context is quite different from your interpretation of the drawing.

The Master: In other words, reducing the volume by the valve does not reduce the pressure on the coil?

The Witness: Not necessarily, at all.

Q. Your pressure regulation in this apparatus, is bound to be by the height of the oil column used here, below the condenser, J, as shown in Fig. 1, isn't it?

A. It would be just as proper for Kittle to put a valve in there, even though he had not mentioned it, and does not mention it, as it would for Adams to claim, in his patent, that a valve is understood, because here he had a pipe with an open end.

[fol. 454] Q. Now, referring to just the structure shown in the Kittle drawing, Fig. 1, the pressure is necessarily limited to the height of the oil column shown in the compartment, K-1, of the tank, K, isn't it?

A. With that limitation that you have mentioned, it is.

Q. And, as illustrated in the drawing, that pressure could not be over a few ounces, if we follow the proportions of the drawing?

A. Yes, provided we do not make use of this paragraph, which has been quoted from page 3 of the patent.

Q. Then, if you were to try to maintain the hundred pounds pressure in that apparatus, that you have stated you understand to be there, by the means which Kittle describes, to-wit, a hydrostatic head of oil, your oil column would have to be between two and three hundred feet high, wouldn't it?

A. If we did that, rather than what he describes, using a valve.

Q. But he describes, in Fig. 1, the oil column, doesn't he, and he says that is the way he gets his pressure—doesn't he?

A. He says he gets his pressure either by sufficiently closing the escape orifice, or by maintaining a column of oil.

Q. He says, doesn't he, that he maintains his pressure in Figures 2, 3 and 4, by closing a valve, and by a hydrostatic head of oil, in Fig. 1—that is a fact, isn't it?

A. No. He says that it can be closed by one of the two methods—either of those methods shown in figures 2, 3, and 4, or the column of oil method, as shown in Fig. 1.

Q. He can get what he calls high pressure, either way?

A. Yes, but I think you are forgetting, here, one portion of this. This vessel, K, if in an automobile, would be, presumably, a closed vessel, and if it was a closed vessel, then you have your system of back-pressure showing on your pump. It would be hardly likely that an open vessel would be used, where the oil could slop to and fro, for example, in an automobile, and the column, K', then, would simply be a scheme for regulating the last portion of the pressure.

Q. Now, if it were closed and vented, as the ordinary tank is, in a car, to prevent slopping around, you still would have precisely the same conditions that you find here—that is, that the hydrostatic head would maintain wha Kittle called his high pressure?

A. There are several suppositions in your last question, which are without basis, I think.

You can vent several places here. You can vent even [fol. 455] above your upper tank, and then if you pumped in a hundred pounds from your air compression, you wouldn't have a hundred pounds up there. And there isn't hydrostatic pressure here. It is an oil pressure.

The Master: That isn't what he is asking you, Doctor. What he is asking you is what Kittle said about depending on the hydrostatic pressure of the oil to maintain the pressure. Does he, or does he not, as an alternative method, depend on a hydrostatic pressure and the column of oil?

The Witness: Only in part, I think.

Q. Now, one of Kittle's purposes was to supply gas, or vapor directly from this apparatus to the burners in gas engines, wasn't it?

A. I think that is correct.

Q. And for that purpose pressures materially exceeding the common pressures at which gas is supplied through pipes, might well be termed high pressures, might they not?

A. My previous answer was correct. I understood it referred to gas burners, instead of gas engines. If he is comparing it to gas engines, he supplies the liquid after it has been passed through the condenser, G.

The Master: Is this for supplying liquid to internal combustion engines?

The Witness: Yes, sir. He says the worm, G, is chilled in any suitable manner, and the vapor condensed therein, so that it is liquid that is supplied to the engine, and not vapor.

Mr. Wiles: I think your correction is right. I was wrong, myself.

Q. One of the purposes, here, is to supply gas directly to burners.

A. Yes, the burner that is heating the lead bath.

Q. He gives two outlets here,—one, *f*-5, and the other *f*-4, one of which supplies the burner under the lead bath, and the other may supply a burner under a boiler—isn't that right?

A. Yes, sir.

Q. Now, for that purpose, a pressure substantially exceeding the common pressure at which gas is supplied to light devices, might well be called a high pressure?

A. In one sense, yes.

The Master: There was in use, in France, before, or about that time, steam coils, or a steam boiler, or a steam engine, operating an automobile. Was this for heating [fol. 456] such a coil as that, by an open burner, or was it

to supply gas, or liquid fuel, to an internal combustion engine?

The Witness: I think it is quite plain that this was to supply a liquid fuel to an internal combustion engine, of the ordinary gasolne motor type—automobile type.

Q. But it does say, does it not, that the material passing out of the pipe, *f*-5, can go to a steam boiler?

A. Yes, sir.

Q. And an ordinary and common pressure for the supply of gas to burners, is our ordinary city gas main pressure, isn't it?

A. That is one type, but in manufacturing plants we often apply a booster to it, to give increased pressure.

Q. But that is the ordinary pressure, is it not?

A. For household uses, yes.

Q. And it is often supplied to burners of all sorts, at that common main pressure, is it not?

A. Yes, for small burners, but generally not for manufacturing burners, or burners of larger capacity, such as are used in manufacturing plants.

Q. Well, the burner which this little Kittle device would supply, would be a small burner, of course, would it not?

A. Not so very small. It would be a burner capable, under a steam boiler, of giving several horse-power.

Q. Now, when you say that in industrial plants they use high pressures for their burners, what do you mean—how high?

A. In the range of 10 pounds to 120 pounds. I installed one over in Long Island City, in a plant that I designed, which, as I recall, uses about 40 pounds pressure. I saw such burners in operation at the Chemical Exposition, which I think were using more than hundred—or around a hundred pounds.

Q. And ordinarily the common gas burner of an industrial plant, will use around, maybe a half a pound, or something like that?

A. If it uses the same pressure as a household would use, it would use still less than that—it would be only—

The Master: What is the main pressure on gas pipes?

The Witness: About five inches of water, which would make it about three ounces.

The Master: City main pressure?

The Witness: Yes—about three or four ounces.

[fol. 457] Q. And when there is a booster used in industrial plants, the pressure is often only around half a pound isn't it?

A. I think when a booster is used it is rare that it is less than five or ten pounds. The booster used is generally of the type of a pump, such as the Connellsville blower, or a Roos blower—those types.

Q. What is the limit of those blowers—do you know?

A. In the Connellsville the practical limit is 15 pounds, of that type. With the Roos we can go up much higher. The Connellsville people, I think, put out blowers that will run up to 40 pounds, but they are not of the proper type, when you want to use as high pressure as that.

Q. Still referring to the Kittle French patent, the representation in Fig. 1 of a body of liquid in the drum, F, is evidently a draughtsman's error, is it not?

A. I think not. I think it is as was intended.

Q. What holds it there?

A. Either the back pressure on the liquid, through the tank, K, or the possibility of putting in a valve, or the valve which he has discussed, but which he has not indicated in the drawing.

Q. Now (having reference to the hydrostatic, or oil static, as you called it, the method of pressure maintenance, which is illustrated in that figure, it is perfectly manifest, is it not, that if the drawing is correct, there would have to be a vacuum in the drum, F, to keep that from running out?

[fol. 458] A. No, you are relieving the vapors through the valve F-3, and the valve at the top of the condenser, G, and if there was any back pressure, for any reason, either from the smallness of the pipe, F_2, or from a valve placed in the pipe, F_2, or from back pressure in the tank, K, and if the pump above there was not running so vigorously as to suck it all out and allow back pressure to accumulate; any one of those three agencies would keep the oil in the tank, F.

Q. Well, the common rule that liquid seeks its own level, applies to oil, does it not, just the same as water and other fluids?

A. Yes, but that was "seeks its own level when it can overcome a back pressure."

Q. Taking the device as shown in the drawings, and presuming that the oil head is what maintains the pressure, the liquid in the drum, F, would run right down, would it not; particularly, if there was any pressure on top of it?

A. May I inquire what you mean by oil head?

Q. The oil head in the oil tank, K-1, is what the patent says, does it not?

A. If there was no back pressure, yes, due to either of the three conditions that I have mentioned.

The Master: If there was more pressure in one direction than there was in the other direction, naturally, it would overcome that?

The Witness: Yes.

Q. If the oil head in the little tank, K-1, is what maintains the pressure, as stated in the patent, then the level in the leg, J, the liquid level of the leg, J, and its extension downward, must be below the level of the oil in K-1, must it not?

A. This is only true, provided that the other suppositions which you have made earlier were correct; that is, that there were no back pressures, no valve, no cover to K, which was vapor tight, and that the tube, F_2, is of large diameter, relatively; all of which suppositions are contrary to the drawing itself, which shows the liquid above it.

Q. That is why I asked if it was a draftsman's error, Doctor; because what I am trying to get at is this: If the head in the K-1 is what maintains the pressure, then all those conditions that you have stated must be true; that is, you have got to have the communication so open that your level inside of the pipe, J, and its extension downward is below the level of the oil in K-1.

[fol. 459] Mr. Rauber: What do you mean by a "draftsman's error"; that the liquid is wrong or that the piping is wrong?

Mr. Wiles: The liquid level can not be up there. The liquid level has got to be down here (indicating) with the pressure at the pipe, J.

Mr. Rauber: They could easily fix it so the oil would overflow in a pipe or outlet.

Mr. Wiles: In the drawing I am showing here, the pipe outlet is at the very bottom of the pipe. Now, hydrostatic head can not permit that, it is just impossible.

Mr. Rauber: But you are asking him which he wants to change, whether he wants to take the liquid out or put this pipe——

Mr. Wiles: I asked him if the liquid in K-1 is the thing that maintains the back pressure, which the patent says it does; whether it is not absolutely necessary that all of this piping, J, be empty; and of course, as a matter of plain physics, it is necessary that it be empty.

Mr. Rauber: This might be partly full of liquid. It could easily be kept so with an overflow. I do not see how it makes any difference.

The Witness: This would be contrary not only to the drawing, but such a view would be contrary to the third paragraph, page 3, second column of the patent, because the oil would not be maintained at a high pressure while it passes through the apparatus. It would be maintained at practically no pressure.

Q. The pressure would be a few ounces in this exact apparatus as shown, would it not, with the liquid level——

A. I do not think that that would hardly be considered as a high pressure for cracking purposes.

Q. It is higher, is it not, than the normal pressure in the city gas mains?

The Master: Let me ask: Is it supposed that the liquids, in F, chamber, F, pass downward through F_2, and the coil J, into the small compartment, K-1, until they fill that compartment and overflow into K?

Mr. Wiles: Yes, surely. That is the operation, and it is that head that maintains the pressure.

The Witness: That is correct, that they do pass in that way.

(The last question of Mr. Wiles' repeated by the stenographer.)

A. I do not understand what you mean by "it."

[fol. 460] The Master: What is the connection with your question? I do not understand your question that the height of the liquid, in K, has anything to do with the ques-

tion of the pressure in K-1, or produced by K-1 in the matter of back pressure.

Mr. Wiles: No, it is not. I thought I had always said, "the height of the liquid in K-1."

The Master: You did say something about K, and about the draughtman's error; the liquid shown in K.

Mr. Wiles: No, in F. F ought to be empty, because it would all run right out. That is the only point I am try- to make.

The Master: It would all depend upon the relationship of the pipe to the quantity of your liquid, and the supply of the quantity of liquid in proportion to the diameter of F_2.

Mr. Wiles: Undoubtedly, but the patent says that it is this hydrostatic head that regulates the pressure, and if that be true——

The Master: Is that the hydrostatic head you have been talking about all the time?

Mr. Wiles: Yes, this head in K-1. That is what the patent says:

May I quote:

"With the object of insuring the conversion of hydrocarbons into more volatile hydrocarbons, the oil is maintained at a high pressure while passing through the apparatus. This is accomplished by preserving or providing some pressure at the discharge end, either by sufficiently closing the escape hole, as illustrated in figures 2, 3 and 4, or else by keeping the column of oil above the outlet opening, as depicted in Fig. 1."

Now, of course, the outlet opening is that opening down in K-1.

The Master: Is not some pressure supplied here by the pump, L?

Mr. Wiles: No, that is the—that makes pressure in the feed tank, which could be cut off entirely by the valve A-1.

The Master: Suppose it is not cut off?

Mr. Wiles: Well, then, the friction head through the pipe coming down would use up a great deal of it.

The Witness: And there would be a similar friction head in the pipe F_2, undoubtedly.

Mr. Wiles: Yes?

[fol. 461] The Master: There would be back pressure to the extent of the column of fluid in K-1?

Mr. Wiles: Yes, sir. But if the pressure is to be maintained by the hydrostatic head, as stated, by the column of oil above the outlet, then the pipe, J, and its extension, have got to be substantially empty, do they not?

The Witness: You would have there another supposition, in addition to these first suppositions that you have made, and that is that the vessel, K, is open to the atmosphere.

Mr. Wiles: Yes, of course. That is the way it is illustrated, is it not?

The Witness: No, there would be no line across the top if it was open to the atmosphere.

Q. Why, you would show the far side in a sectional drawing, would you not?

A. You might or might not.

Q. Now, in Fig. 1, where there is a cover shown on it, you have got the cover sectioned, have you not?

The Master: Cover shown on what?

Mr. Wiles: The big tank has got a cover on it.

The Master: That is K?

Mr. Wiles: The tank, E, has got a cover on it.

The Master: The tank, E, has got a cover on it.

Q. And the cover is shown with the double lines sectioned, is it not, the same as the sides?

A. Yes.

Q. And when you come down to the tank, K, the sides are sectioned, are they not; the sides and bottom are double-lined and sectioned to show that it is a section; that is a fact, is it not?

A. Yes.

Q. And the top is a single line just the way the top of an open tank would be illustrated, is it not?

A. Not normally when we are putting—making a sectional drawing, you may leave it without. You may put a dotted line across there, as he did in the question here, with the coils over here (indicating).

The Master: The ordinary draftsman would read that as an open tank, would he not?

The Witness: I am not certain that he would. From the drawing itself it might be read that way, but reading the context, there is a question in my mind as to whether it would.

[fol. 462] Q. Will you just turn to Fig. 4 and tell me whether the tank, R-1, is an open tank or not?

A. I would presume not, but I do not know.

The Master: The same thing might apply to B in Fig. 4?

Mr. Wiles: Yes, surely. It is a regular, water-condenser tank.

The Master: What is the little outlet on D-1; is that an overflow nozzle or release pressure nozzle?

Mr. Wiles: My answer to that is let the witness answer.

The Master: You answer it.

Mr. Wiles: The tank, D, is a regular, water-condenser tank.

The Master: I understand, but what is that, outlet?

Mr. Wiles: One of them is for the water overflow, and the other at the bottom is to take the water into the regular, open water condenser tank.

The Master: If it is just an open tank there, why put that little opening or spout on the top end of it?

Mr. Wiles: To make the water flow out in one place so you can lead it to the sewer instead of spilling all over, the way you always build a condenser tank. Every condenser box is built just that way.

Q. Now, Doctor, have you answered my question as to whether R-1 is an open tank or a closed tank?

A. It is a tank holding oil, and I presume in any plant, it would be kept as a closed tank. It is not customary to expose it.

Q. How about the tank, D, the condenser box; is that open or closed?

A. In which?

Q. In Fig. 4.

The Master: I think it might be either open or closed, to suit the taste of the operator or user.

A. It will be noted, Mr. Wiles, here, that you can get an answer to your question of your draughtman's habit, that he is not at all consistent in here; for example in Fig. 3, if

you will take the outlet faucet, there are simply two lines without an oval around it.

The Master: Which one?

The Witness: This one (indicating). Whereas, in another place there, in Fig. 3, in the vessel to the right, the faucet there, which is apparently an overflow faucet, has no line across it. In the Fig. 2 above, which is apparently a similar one there, it does have. In other words, he is not consistent.

[fol. 463] Q. That is not what I asked you at all.

A. It is what you asked me.

Q. Just answer my question: Is the tank, D, in your judgment an open top or closed top tank?

A. Condensing tanks are generally made closed top, and I would presume that this was, because the figure would agree with that. It might be interpreted the other way, if you care to.

Q. Now, where have you seen closed condenser tanks in common use?

A. In a plant that I ran during the war-time at Richfield Park, New Jersey, employing approximately 150 men.

Q. Where else? Have you ever seen them in an oil plant?

A. Most of the condenser tanks that I have seen in oil plants have not been coil condensers, but have been flat, wood square boxes, or rectangular boxes, with the pipes as straight pipes. Moreover——

Q. Well, were they open or closed?

A. How is that?

Q. Were they open or closed?

A. Those were open, but a vessel to be used as a condenser in an automobile—to be carried by an automobile, certainly would be a closed top condenser to avoid splashing as you went over——

Q. So you think that the tank, K, is intended to be illustrated as a closed tank?

A. Yes, otherwise that top line would not be on it; that top horizontal line.

Q. Well, how would you draw it if you wanted to show an open tank?

A. Without that top horizontal line.

Q. There would be no line at all at the top?

A. Yes, sir, just as in the case of the faucets there in Fig. 3.

Q. Now, referring again to the specification of this French patent, I find the following (This is on page 6 of my translation. I do not know where it will fall on yours; it is the page after the dimension table:)

"The excess and non-vaporized oil, as well as the impurities are conducted into the tank, K, under a constant column I I, contained in the chamber K-1."

Now, that column cannot exist as a pressure column, unless the pipe, J, is substantially empty, can it?

A. All I think that means is that the overflow diaphragm intermediate in the tank, K, has a standard level of height of I-I. Certainly, the liquid from K-1, overflowing into K is not overflowing under a head, excepting the few fractions of an inch above the diaphragm, which is shown as splashing in the drawing—where the water is overflowing and splashing in the drawing.

[fol. 464] Q. In order that the liquid column, which is marked I-I, the vertical limits of it are given in the drawing as I-I, with dotted lines, in order that that shall exert a back pressure on the substances entering it through the pipe, J, what must be the condition in J as to its being full or empty?

A. If J was a tube of large diameter, so that there would be no friction in it, instead of being as it is a tube of small diameter—if it was such a tube of large diameter, and also if the pump, L, was not working with a forced feed, and also that the tank, K, was not a closed tank under pressure, and also that the feed of oil through the lines D, the coil, B, and the valve, A', from the vessel A was small in amount, relatively, then, on those four or five suppositions, the pipe, J, would be essentially empty, but the context does not agree with those four or five suppositions.

The Master: The only issue between you and the witness is the question whether there is pressure or not pressure, is that it?

Mr. Wiles: Yes. Partly that; there are a number.

The Master: And the argument you are making is from the drawings of the patent?

Mr. Wiles: And its language. It says expressly that this little head marked with the capital letters I-I, is what maintains the pressure.

Mr. Rauber: Not exclusively, does it?

Mr. Wiles: Yes, in that figure.

The Master: Now, listen to this:

"In carrying the present process into practice, it is necessary to take care so that the pressure in the oil reservoir, the temperature to which the same is heated and the speed of the oil stream across the vaporizers are maintained at constant value."

Mr. Wiles: Yes.

The Master: Then he does call for pressure, does he not?

Mr. Wiles: In the oil reservoir. That is, the tank up there that feeds the cold oil.

The Master: Oh.

Mr. Wiles: Not after it has passed the valve, A-1. There is 100 pounds on the cold oil.

The Master: What does "the temperature to which the same is heated" refer to?

Mr. Wiles: The oil that is fed through the cracking coil, D.

The Master: "The pressure in the oil reservoir; the temperature to which the same——"

Mr. Wiles: That means, evidently—it can not, because there is no heat on the oil reservoir. That must mean the oil from the reservoir.

The Master: Well, then, "the same" refers to oil, does it?

Mr. Wiles: It must mean the oil.

The Master: And not the reservoir?

Mr. Wiles: Yes, probably it says in the French, "the reservoir of oil and the temperature." I did not read the French, but that probably accounts for the curious English grammar.

Mr. Rauber: I think if you read the French you will determine that it does mean that.

[fol. 465] The Witness: It is to be noted, your Honor, that the next sentence is:

"Provided with suitable regulating valves"—not a single one has been referred to there at A-1, but with a number of valves to be regulated so that the pressure and so on may be ample.

Mr. Wiles: I think there is, perhaps, one more question.

Q. You stated in your last answer a number of qualifications. If the column, the limits of which are definitely marked in the drawings by the capital letters I-I, is to exert any pressure at all, then the lower end of the pipe, J, has to be substantially empty, does it not?

A. No, not if any of the suppositions, the four or five in number that I made here, not as you said but as I believe.

Mr. Wiles: Now, let me get one more question on that point?

Q. If the level in the pipe, J, the lower end of it stood as high or higher than the J at the top, could you say that that column, K-1, was exerting any pressure?

A. Yes, if the vessel is itself under pressure; is a closed vessel under pressure.

Q. But it would not be the column, then, it would be the pressure of the atmosphere above it, would it not?

A. It would be both.

Q. The column would not exert any pressure, would it; you would simply have a balanced column, with oil in the pipe, and oil outside the pipe, and neither column would be exerting any pressure, would it?

A. You can take as balancing the distance, or as balancing either part of the pressure you please, the pressure which is in the tank, K——

Q. In other words, the moment we let the liquid level rise in the pipe, J, to upper I, from which the dotted line goes over, you have destroyed the pressure effect of the column, have you not; neutralized it?

A. You have an equivalent of it, but it is not necessarily you have destroyed the effect of it. That can easily be seen if you would take the vessel, K, and K′, made as it is there, and punch a hole at a lower point, or take out that little diaphragm, not all the way out, but three-fourths of the way down, and if K was under pressure, you would still have the pipe, J, with liquid in it from I to I, and higher due to the pressure in K. Now, if you take and add to it, say, until the

level is up as high as J in there, just at the beginning of the coils, and then would put back your diaphragm, still keeping it under pressure, and fill it up with oil there, you would raise the level in J, from J up to a higher point, say, to the top of the coil which is about the equivalent. So that we would say then that your column that you put in there has not been from II, it has been from the bottom of the coil to the top of the coil; it has raised the level that high.

Q. Now, the patent says, does it not, that it is the column between the two I's?

A. The patent says in the second column of the original French, lines 75 and 76, reading the preceding part of it:

"This is realized by retaining some pressure at the discharge end, either in sufficiently closing up the escape hole, as shown in figures 2, 3 and 4, or by maintaining the column [fol. 466] of oil above the outlet orifice (I believe as you have it) as shown in Fig. 1."

Now, the outlet orifice, is the orifice of the tank F, is it not?

Q. No, because the patent in the other place I quoted you says that it is the column under a constant head I-I, contained in the chamber, K-1, and the other page that I quoted you——

A. But this was the part you quoted earlier, of maintaining oil above the outlet orifice.

Q. What?

A. (continued). Of maintaining oil above the outlet orifice.

Q. Exactly. And the outlet orifice is the one down there at the lower end of the condenser pipe, is it not, or the cooler pipe, J?

A. Well, I would read the figure with its oil above it as the outlet orifice of a tank, F. That is the cracking apparatus.

Q. Then you understand that the oil column above the outlet orifice, which maintains the pressure, is the column in the tank, F; is that your present position?

A. Using the translation which we have just had given off the record, I would say that it is not altogether clear. It could be that either in the tank, F, or that in the tank, K'.

Q. Now, as a matter of simple physics, the liquid in the tank, F, above the outlet of that tank, not only can not maintain pressure but has to be held up there by external pressure, does it not?

A. Yes, or friction or some such scheme.

Q. In other words, it has no function in maintaining pressure; it can not have.

A. Yes, it can have a function.

Q. Does that not, in fact, by the mere weight of that column, tend to reduce rather than raise the pressure?

A. If this was not there you would have escape of vapors [fol. 467] through, and as such its existence there does have a function in preventing the escape of vapors and in keeping the pressure vapors having much less viscosity which could go out and would reduce pressure rapidly.

Q. Now, the mere weight of *w*hat column tends to reduce pressure, does it not?

A. If your tube was large enough and there was no pressure in the vessel, K——

Q. So that it, as a column of liquid, can have no effect in maintaining the pressure.

A. I said a few minutes ago in the next to the last answer, that it did have an effect.

Q. It has a function just as a seal, not at all dependent on its height, according to that answer.

A. Primarily as a seal.

Q. And it would have just the same effect as a seal if the level were anywhere clear down to the lower I in the drawing?

A. No.

Q. Why not?

A. Because we would have the counter-balancing of the liquid in K′ and we would have the pressure in the vessel, K coming in as entering elements in such——

Q. In other words, the lower that liquid level is, the higher the pressure will be; that is a fact, is it not? That is, the lower the liquid level inside the pipe, J, the higher the pressure will be; that is a fact, is it not?

A. You are referring to the vessel, F?

Q. Yes.

A. No.

Q. Pressure in F?

A. No, because if part of the space is occupied in F, then the vapor- there in F will cover more pressure than if they had the whole space to be used for those same vapors, and the liquid here is given as occupying J and F, and I think without question that anybody should see that, if your space is partly occupied by liquor, then your vapors, which are of the portions coming through, must have a higher pressure than if you keep all the space free from liquid for the same vapors.

Q. You would have the same vapors in any of these continuous processes; you have a constant stream coming in and a constant stream going out; the volume in the system makes no difference to the pressure at all, does it?

A. Yes, it does. Because, for example, here in this vessel, [fol. 468] F, and in the tubes both we are cracking this product, and the more volume, the more oil is exposed to the cracking, the more gases are formed and the higher the pressure.

Q. Well, now, just what is it in any system of this kind that determines the pressure? It is the setting of your outlet, is it not?

A. The setting of your outlet and also the setting of your inlet. For example, feeding oil in under 100 pounds pressure, as is so suggested here——

Q. Now, if you have, in any pressure system at all (We are going to have a lot of them in this art and we might as well settle this while we are at it)—in any of these pressure systems, if you have your outlet set at a half a pound, that is going to be the pressure, because everything will go out at that outlet if it is set for that pressure?

A. If your outlet is set at a half a pound it will. If your outlet is set for 100 pounds and your inlet is only 10, you won't have over ten pass the outlet. That decides it naturally.

Q. But you cannot go above the outlet pressure, can you?

A. No.

Q. If your outlet is of adequate size?

A. No, you cannot.

Q. Now, take this Kittle device and suppose that instead of this oil column down there you have a loaded valve set for a half a pound, what will be the pressure in the system?

A. What is your pressure on the other side of your valve?

Your half a pound would only be the difference—if, on the other side, you had a hundred pounds or fifty pounds, it would be fifty and a half pounds or one hundred and a half pounds.

Q. I am assuming the pounds. Supposing you have got the loaded valve set for half a pound and the atmosphere on the other side of it, what will your pressure be?

A. Your pressure at half a pound, if your pipe leading to it is adequate in size——

Q. Is it not a fact that the amount of liquid in that system will not make any difference at all?

A. It will make a difference in it if the vapors cannot get out readily.

Q. Assuming you have an adequate outlet valve, of adequate size set for a half a pound, your pressure is going to be half a pound, is it not?

A. That is for your liquid and vapor gas outlet?

Q. Yes, everything.

[fol. 469] A. Everything?

Q. Yes. Everything will go out of there until you get a half a pound, will it not?

A. It will, subject to any friction in the pipe.

Q. And it will not make any difference how much liquid you have in the system at all, you will have a half a pound and you cannot get any more?

A. If your outlet is large enough.

Q. Is big enough, exactly. Now, if you have got a column of liquid up above this half a pound loaded valve pressure, your system has got to be a little less than a half a pound, has it not, by the amount of the height of the column?

A. If you are working only against atmospheric pressure.

Q. Exactly.

A. (continued). And have a pipe that is a large pipe.

Q. In other words, the liquid in there pressing against the outlet tends to lower the pressure, does it not?

A. Well——

Q. The greater the height of the column, the lower the pressure?

A. On these other suppositions we have had in the previous questions.

Q. Now, if you take a device like this of Kittle, where, instead of the loaded valve we have just been talking about,

you have a hydrostatic head of about ten inches of oil, which will give you about a half a pound, or thereabouts, you will have just exactly the same condition, will you not?

A. No, because here you have got a small pipe; here you have got a tank, K, that is under pressure; here you have got, so far as the drawing indicates, a small orifice out from F. If you will put a lens there on that you can see that that outlet from F is quite small in cross section.

The Witness: I wish to call your Honor's attention to this (indicating). Put a lens there and you will see the small opening; this small opening right there (indicating).

The Master: Smaller than the——

The Witness: Pipe.

The Master: —inner diameter of the pipe?

The Witness: Very much smaller.

Q. Now, you started out with the suggestion that maybe the tank, K, was under pressure. In your extremity you seem to have positively put it under pressure; what new basis have you for that?

A. I do not think that I have reached any extremity for [fol. 470] making a change in policy, but on the question of suppositions, which you are making, which I feel to be contrary to the facts——

The Master: You answered it according to the hypothesis?

The Witness: Yes.

Q. You just said, did you not, that the tank, K, stated positively that the tank, K, was under pressure, in your last answer, did you not?

A. I do not remember what my phrasing was for that.

The Witness: Will the Reporter read that?

The Master: I think he said "If the tank"——

Mr. Wiles: Excuse me, your Honor. I do not want to contradict you, but he said, "Here we have a tank that is under pressure."

The Master: You are perfectly at liberty to contradict the Master.

Q. Now, whatever these frictional losses, friction resistances to the flow-out, the more liquid you have in the

column, J, the easier to get out, the more pressure you will have tending to push it out, will you not?

A. Yes, the higher your pressure. That is easily seen, for example, if you will take a material of heavy viscosity, like cold molasses, and put it into a narrow pipe, such as this, of the size of a lead pencil; the flow through there will be frictional, will increase the pressure in the vessel, F, and the cracking coils, D.

Q. Exactly; and if you have a deep column it will flow faster than if you have a shallow column, because the hydrostatic head will be greater, will it not?

A. No, not if it is a material such as suggested in my last answer, in the way of molasses or something of that kind.

Q. Suppose it is oil like this; the deeper your column the faster it will tend to move, will it not?

A. That depends on the diameter of your tubing, and how much the friction on your tubing is. If your pipe is wide enough, yes; but if you pipe is real narrow, no.

Q. Whatever it is, there will be more tendency to flow in a deep column than a shallow one, will there not?

A. There is more weight to bring about such flowing, but there is also more friction on it, so that we cannot say as to which will be the greater.

Q. It would not flow at all if your friction was greater than the weight, would it?

[fol. 471] A. We would have, in this case of rather cold molasses, practically no flowing.

Q. It would not flow at all if the friction was greater than the head?

A. It would not.

Q. So that the head has got to be enough to overcome the friction, has it not?

A. Yes, we must have pressure enough above it to overcome it.

Q. And the deeper it is the faster it will flow, other conditions remaining the same?

Mr. Rauber: That is assuming when you increase the length of your pipe, the friction remains the same. Of course, when you increase the length of your pipe you increase the friction, do you not?

Mr. Wiles: But you have always got a margin. It would not flow at all if your friction per unit of length were not enough to let it flow, so the longer you make it, the greater margin you have over friction, have you not?

Mr. Rauber: No, not if you are forcing it through under high velocity pressure of vacuum.

Mr. Wiles: We are dealing here purely with hydrostatic heads, as I understand them.

Q. Now, in F, you are not increasing your friction at all as you deepen the column in F, are you?

A. The amount of surface is small there.

Q. Exactly. So that the deeper the column in F is, the greater pressure you have tending to drive the oil out through the condenser, J, or cooler, J; that is a fact, is it not?

A. Yes. Also, probably the greater the pressure, we would increase rather rapidly. The more liquid in F, we would increase the pressure of the gases there.

Q. I thought we had just gone over that once.

A. We have.

Q. Did you not just say here a few questions ago that the amount of liquid in F in a constantly fed system like this, did not control the pressure because it would drop down to the pressure determined by the resistance of the outlet?

A. That is true in constantly fed ones, but in my last——

Q. This is con-tantly fed.

A. Please let me finish my answer.

But in my answer to the question I said if we increased [fol. 472] the liquid in F rapidly (I do not know whether I used the word "rapidly" or "quickly") it would change the pressure.

Q. Instantaneously?

A. Not instantaneously.

Q. Suppose you had two inches of liquid in F, there will be just two inches more head tending to drive the liquid out, will there not?

A. Out of what?

Q. Out of the system through J.

A. Yes.

Q. Then the liquid will tend to flow faster through J, will it not?

A. Yes.

Q. Then you will need less gas pressure behind it to cause it to flow?

A. That is correct, on the supposition that it is the head of liquids that makes it; whereas, if you look once on this diagram, you will notice that the outlet from F to the pipe F_2 is made here of very small size. Perhaps you would like to use a lens in looking?

Q. I have one, always.

The Master: The contention is that it needs the pressure of vapors in the upper part of F to assist in expelling the liquids?

The Witness: Yes.

The Master: From the bottom of F?

The Witness: And that you have there more pressure than that due to the column, I-I, and if the vessel K is under pressure, it is quite likely that as well.

The Master: Of course. In other words, that the gases will be pressing against the head in I-I; that is, in the receptacle K-1?

The Witness: Yes.

Q. In the particular supposition that you last made, it is the friction resistance that determines the pressure and not the column, I-I, as stated in the patent, is it?

A. No, that is only part. The regulation would be——

The Master: I do not think that is fairly inferable from what he said.

A. Friction is only a part of the column; the column II is under part pressure. If the tank, K, is closed, which I think it is, and you think it is not, it would be another portion.

Q. I am trying to get back to the statement you interjected sometime ago, that the height of the liquid in the [fol. 473] drum, F, is what controls the pressure. Now, the column that does that——

A. May I interrupt?

Q. Yes.

A. I call your attention that I withdrew that when the other translation was made off the record, and called attention there that in view of the translation which was made off the record, I corrected it.

Q. Oh. We have been at cross purposes, but I do not think the record will show that that is what happened.

The Witness: Will the reporter please read that?

Mr. Wiles: We will get your present position.

Q. Your present position is that it is not the column in F which maintains the pressure, but it is the column I-I, as stated in the patent?

A. I do not recognize any column in F there. There is liquid above the floor closing the orifice.

Q. Yes. That is not the one referred to as maintaining the pressure.

A. I would understand that that pressure was maintained partly by the small orifice there, partly by the friction through the pipe, J, partly by I-I, which is one which may be varied by varying the height of that diaphragm; partly by the pressure in K, if K is closed, as I think it is, and you think it is not.

The Master: All this whole discussion now that we have been going through this morning, and up to this time, as I understand it, is for the purpose of determining whether this patent discloses distilling under pressure or not?

Mr. Wiles: And how much pressure and how long the time element is, all of which is extremely material.

The Master: No time limit is fixed in the patent, except as it is inferable from the terms of the patent.

Mr. Wiles: From the feed rate. He gives the feed rate; the witnes has told what the time element is.

Q. In the Kittle process, as a matter of fact, in its operation, with the stock described by Kittle, and at the rate described by Kittle, and at the temperature described by Kittle, what will be the quantity per hour of material withdrawn through J?

A. I do not find a statement in the text of the patent, and of course, it is not obvious from the illustration, as to the amount of liquid that would pass through J, so that I cannot say with certainty. I would presume that it would

[fol. 474] be approximately the same as would be expected of any other cracking process, in the way of residues, when working at temperatures of five hundred or six hundred degrees Centigrade, which is a quite high cracking temperature.

Q. Now, these residues will differ, will they not, in proportion in different processes, different temperatures, and so forth?

A. Yes, and even more so when dealing with different oils.

Q. Now, I have never run or caused this Kittle process to be run, Doctor. I have some others, but not any very close to it, and I want your very best judgment as an expert in this art, as to what, as a practical matter, would be the residues that would go off through this pipe, J, in this process.

A. You are, I understand then, asking a guess rather than for a fact as to what would go off?

Q. I want to know. If you do not know about it at all, why, you might say so, of course.

The Master: The residues might be one thing at one time and another thing at another time, might they not?

The Witness: They might easily.

Q. Kittle names three things, does he not; Kittle names his stock, and his temperature and his rate; and he has got the size of his apparatus——

The Master: Then you are assuming it operated with precision and absolute regularity?

Mr. Wiles: I would like to know, within limits, if there are limits, your Honor.

Mr. Rauber: You mean a list of the hydrocarbons he gets out of it, by name?

Mr. Wiles: He draws the residue out of this lower part, which, I presume, is the stuff which is not liquid and which is not vapor, at 500 Centigrade, which I believe is his running temperature. That is right, is — not (addressing the witness)?

Mr. Rauber: How do you want him to define it?

Q. His temperature is 500 Centigrade, is it not?

A. Yes.

Q. And he feeds eight gallons an hour; that is right, is it not?

A. I think so.

Q. Well, now——

A. (continued). You calculated it and I accepted it this morning.

Q. Well, that is about right. Now, out of that eight gal- [fol. 475] lons an hour that he feeds, how much will he make which will not go through the vapor outlets, but will go off as a liquid out of the bottom of this drum, F?

The Master: You said it was about twenty-five per cent this morning.

Mr. Wiles: He said twenty-five per cent gasoline this morning.

The Master: I understand. Then the residue would be going off as seventy-five per cent, would it not?

Mr. Wiles: That is what I want to find out.

The Master: Most any school boy could make that answer.

Q. There would be, in addition, some gas—considerable amounts of gas itself at these high temperatures, your Honor, as well as the gasoline, because they are cracking at high temperature here.

Mr. Rauber: I think there is a misunderstanding in regard to this question.

Mr. Wiles: Wait a minute. Let me do the examining.

Mr. Rauber: All right. Explain yourself.

Mr. Wiles: I will explain it.

Q. Did you intend to indicate that there will be in the order of seventy-five per cent of the eight gallons an hour withdrawn through the cooler, J?

A. I think this morning what I said was that in such cracking processes, we ordinarily get yields of twenty-five per cent gasoline on one passage through, or perhaps I did not mention one passage through, but we ordinarily get yields of approximately twenty-five per cent in most cracking processes, figuring on the finished product.

If we take crude gasoline with its bottoms of kerosene type, and all the other products, and the gas losses there, we get, as I stated at my last day of examination previous to today, which was Thursday—for example, at the Provi-

dence plant, they were said to be getting there about twenty-five per cent of residues, in fact, a little less than twenty-five per cent about twenty per cent of residues.

Q. Doctor, you may assume that I know the Burton process. I want to know about that Kittle process, in your judgment as to the amount of residues that it would produce.

A. I would expect, though this is only, of course, an opinion, for I have not carried out the Kittle process, and moreover it would vary with the raw material used, even though it was gas oil from various kinds of crude oil, it would vary also with the schemes of operating it. You can- [fol. 476] not always operate at the same temperature. I should say that this residue would vary, in general, between fifteen per cent and fifty per cent of the oil fed in, and that it is difficult to get, from the knowledge which is disclosed in the patent, any exact determination; not only difficult, but that no disclosure is made as to the amount of residues.

Q. And your best opinion is that the residue is from fifteen to fifty per cent?

A. Not is, but might be.

Q. Well, would be?

A. Will be in between that.

Q. Now, would that be true if the pressure were what I have assumed it to be, somewhere around a half a pound or a pound?

A. If your assumption was made that it is only a pressure of a half a pound or a pound, you would have your percentage lower of residue. That, of course, would not agree with oil, as liquid oil, being in the tank, F, as indicated by the patentee; that is, at those high temperatures. If it was only a half a pound to a pound, there would be very little liquid in F, and the fact that that is given shows that it is at a higher pressure, because it has not boiled away.

Q. Just what will be the nature of this residue which remains liquid at 950 degrees Fahrenheit?

A. When we crack gas oil, it will boil, we will say, eighty-five per cent below seven hundred degrees Fahrenheit, fifteen per cent above that. When we crack it we get some heavier products, as well as some lighter products. That, in general, is the customary cracking process as it has been brought out several times before during the hearing. That is, we do not get only light products, we get some heavy

products, when we carry out our cracking process. Now, if we get products by this cracking process, which are heavier than gas oil, they would boil more than the percentage which would boil about seven hundred, larger than the percentage of fifteen per cent, as in the case of gas oil, and it would be this particular fraction, presumably.

Q. The chemical examples which you gave in your direct did not show any of the cases of the kind which you say always takes place, did they?

A. No. You refer, I presume, to the first testimony I gave, where I was illustrating, in the simplest form possible, the cracking, and gave certain formulae. In those cases I [fol. 477] did not discuss that, but it has come up several times since in the hearing.

Q. Then, those formulae did not represent what actually happens?

A. They were illustrative of the formation of gasoline, I think, and the cracking——

Q. You mean a formation which might happen?

Mr. Rauber: I think the inference in that question is wrong, and I object to it on that ground. Those reactions and those equations were not supposed to represent completely every reaction that might take place in a cracking process.

Mr. Wiles: I did not suppose they would, Mr. Rauber. Of course, I did not expect them to show everything that might happen.

Q. But my question was: Those were simply possible reactions, were they not, that you illustrated?

A. No, they were more than that. We know, for example, that such materials as tetradecane and as heptadecane occur in the starting material, and that by cracking we can change those kerosene-like products into products of gasoline type of octane; and hexylene, also carbon and hydrogen, such as were mentioned in those charts.

Q. Always you have this formation of a heavier fraction than you start with, do you not?

A. You have a residue formed, such as in this case it would be identical with that formed in the Burton patent, or the X, Y, Z, or your twine oil patent, which we had this morning. That residue would be of the same character here, an oil of light viscosity, somewhat unsaturated; which

would be fairly high density and high boiling, which is the same kind of oil as we form, in general in cracking.

Q. That would have to be formed by reactions quite different in kind from those you described in your direct?

A. Is that a question?

Q. Yes.

A. I described this morning the reaction, also in my direct, but if you are referring to the early work, to the early first days' work, where I was attempting to show how gasoline was made, not to show how twine oil was made——

The Master: Not dealing with the residues at all?

The Witness: Not dealing with the residues, but only with the commercially important products.

[fol. 478] Q. Didn't the reactions that you illustrated, show residues besides, but not the residues which actually happened?

A. Besides what?

Q. Besides the gasoline?

A. Yes, but only because those residues were necessary to illustrate the formation of gasoline. I was not discussing the other oils that were formed.

Q. I realize that, but you did show gasoline fractions, or a compound which might be in gasoline, and a residue compound, but the residue compound was not the kind that we actually get?

A. The residue compound, in that particular case, was carbon, and the gasoline compounds were compounds that we actually get when we crack oils to get gasoline.

Q. Didn't you show some liquid residues other than gasoline? I thought you did, but I may be wrong.

A. I think not.

The Master: In other words, you were only dealing with lighter boiling points of hydrocarbons derived from the cracking system at that time?

The Witness: Primarily, yes, and I spoke of carbon residue and hydrogen gas, in addition.

Q. Taking this Kittle process, further—you have stated that the residue, of high boiling point which comes out through J, will run from 15 to 50 per cent. What will be the other products, and their proportions?

The Master: He said it might be 15 to 50 per cent.

Mr. Wiles: I didn't mean to misrepresent, but I thought he——

The Master: I don't think this witness can state, in proportions, what would be the result of the process shown in the Kittle patent. I think that would be a pure guess.

Mr. Wiles: If I assume that, then I am led to this next question:

Q. Can you tell, from anything in the Kittle patent, or from your knowledge of the art, even today, whether the Kittle process is a practical commercial process, for the manufacture of motor fuel?

A. If you mean, by that, that you can make gasoline by this process—or motor fuel, by this process,—I would say, yes. If, on the other hand, you mean that you can make it and pay a dividend by it, I doubt it.

Q. In fact, you are pretty sure that you could not, aren't you?

[fol. 479] Mr. Rauber: I don't think that question is competent, and I object to it, your Honor.

The Master: Furthermore, wouldn't it be true that for one person having this Kittle patent, and having all four corners of it, and all of its teachings, and all that anyone, at that time, was supposed to know about the art—schooled in the art—one man might set up a plant, which his engineer would construct from this patent, which would differ, somewhat, and, perhaps essentially from what some other engineer taking the same patent, might set up?

Mr. Wiles: Surely, your Honor.

The Master: They both employ the disclosures of the patent, but the result of the two mechanisms might be somewhat different, and, perhaps widely different—isn't that true?

Mr. Wiles: Yes, your Honor, but if it is very widely different, and the patent is so ambiguous that you can not tell—

The Master: I have no doubt, if you wanted to, you could set a Kittle apparatus out in your own yard, and have somebody come in here and testify to what it did, and the classic method of doing that would be to have it perform not at all.

Mr. Wiles: The right way to do it is to invite the other side to witness it and let them run it. But, of course, as to

all this art, it is a vitally important matter, whether these people really have practical processes that will run and pay a dividend, and if they don't——

The Master: It is a question as to whether they could run. It is not a question of paying dividends. We are interested in the scientific and technical disclosures that enter into it—that would enter into a plant that could pay dividends.

Mr. Wiles: This being a process, your Honor, I think the question as to whether it lacks commerciality, is of real importance, and I think it is of all this art, because it goes to what was accomplished by the defendants in the way of actually making processes which did pay dividends.

I want to say to your Honor that to our minds the thing that your Honor stated—the technical and scientific and chemical phase of this case, is of aboslutely no consequence whatever. We do not think that it amounts to anything, from the patent angle. Our position is that this art was rather completely developed, in a great many respects, on paper, and the problems were wholly—almost—practical ones, of developing those things, which made the thing run on a big scale.

The Master: In testing these patents that are in question here, the rule is that it is not the length of the step that is taken, but it is a question as to whether an advance step, at all, has been taken.

Mr. Wiles: Of any importance.

The Master: And if the step, however slight in advance, results in something useful and commercially profitable, the inventor is entitled to have his patent considered. You will not be deprived of that, at all.

Mr. Wiles: No, we do not expect to be.

The Master: But the critical point would be as to whether, in some particular patent, there was any step taken, at all, forward, or whether it was taken backward.

[fol. 480] Mr. Wiles: Exactly.

The Master: And whether some of them didn't revert to things that were old in the art.

Mr. Wiles: I realize that that question will be here, but my attack on that, throughout, is not on this theoretical angle, at all, but on the practical questions that go to make up manufacturing costs. We are not remotely interested in the chemical reactions that occur, or whether anybody

knew that they could occur, but what we did that saved money, and produced bigger yields, and that is the only angle that we are interested in, and that is the only one from which we can expect to take these patents, at all, except some that are ambiguous in their disclosures.

But the whole position of the defendants depends upon the practical questions of cost and yield, and those are the things that I propose to examine this witness about, on the prior art, and if he doesn't know, I just want him to say so.

The Master: I know that he doesn't know as to this Kittle process. If he told you that he knew, I would be very much surprised—not to say shocked.

Q. Does the Master correctly state your position, Doctor?

A. I said, I think you could make gasoline by this process, but I don't think, in the small units in which it is described, it could be made profitably.

The Master: There might be some fool who would take it and make it into very large units—then it might be made into a very profitable venture.

The Witness: It might be, but I doubt it, because this lead bath scheme is an expensive scheme for handling materials.

Q. Will you now turn, please, to the Schuchow & Gavrilow patent—that patent states, does it not, that its object is the continuous fractional distillation of petroleum, and other liquids, and also the continuous recovery of gas from petroleum, and its products?

A. It is so entitled.

Q. And gas can be recovered from petroleum without any cracking, can it not?

A. No, not in general, it cannot. Only where you would be getting a crude oil and gas out of the well simultaneously.

Q. If your refinery is at the well, or close to the well, and you could take your crude direct from the well, you will get gas off without cracking, won't you?

A. Yes, in such a case as that, you will get some.

Q. And in the ordinary course of fractional distillation you do recover, always, some gas at the beginning of the distillation, don't you?

A. Yes, but you would not do, as he does, run back and re-use the residue, if you were going after gas, or even fractional distillation, without cracking.

[fol. 481] Q. In fractional distillation without cracking, you often re-run a part of your material with your next charge of raw material, don't you?

A. In fractional distillation without cracking, we don't re-run our residues, as Schuchow & Gavrilow do.

Q. Isn't that just a question of what your residue is, and what you want out of it?

A. I would say not. For example, reading from the translation which you have furnished me, and which I have not seen until this instant:

"Petroleum, or its residues flowing into the top, may be taken."

Now, if we use those residues and fractionate them in a process which gives gas, they would, in the first place, carry no gas, and, in the second place, if we were wanting to make a straight distillation, or straight fraction, it would be very foolish to use pressure in handling them as these gentlemen do.

Q. They sometimes use pressure and they sometimes do not—that is the fact, isn't it?

A. On what? In straight run distillation?

Q. In Schuchow & Gavrilow pressure is sometimes used, and sometimes not, isn't it?

A. I don't recall any evidence of any case where he does not. Possibly there is.

I do find, in this third paragraph, not counting the title, that he speaks of "Petroleum or its residues, flowing into the opening, R, of the pump, B, is taken by this pump and under considerable pressure is forced through the pipe, C, into the coils, ddd—that is, the cracking coils."

And then, later, in the same paragraph:

"In these coils the liquid being put in them by action of the pump, is heated to a high temperature, and dependent upon the dimensions of the pipes and coils, and the speed at which the pump is operated, it is subjected either to the process of distillation, or to the process of decomposition, in addition to which the pressure, under which the process is carried on, is regulated by the cocks, M and P, as will be shown later."

And then, later on, it discusses how M and P may be handled to keep this pressure.

Q. Your reading, then, is that this is always operated under pressure?

A. I said that I did not find in this translation, which has [fol. 482] just been handed to me, a statement that it was not operated under pressure.

The Master: If there is a part in it that indicates that it may be used without pressure, call the witness's attention to it. There is no use wasting time in the witness trying to find something that may not be there.

Mr. Wiles: My memory may be at fault, but my impression of this patent was that it was there, the other way. When I try to carry in my head a hundred and eighty of these patents, I have a little trouble in remembering which is which, and I may be entirely wrong on this one.

Q. Now it is very clear, is it not, that a large part of his work is straight out fractional distillation?

A. I have not so read the translation. I have not, of course, been able to read Russian, but, as I read it, it is almost exclusively, if not exclusively—in spite of the title—concerned with the cracking processes.

Q. Now, I noticed near the bottom of the second page of the translation, the statement that in the distillation of high boiling kinds of petroleums and residues, there may be introduced into the opening of the pump, which receives the petroleum, through the cock, T, light petroleum products, such as benzine and gasoline. Now, that light material necessarily is introduced for the same purpose that you use steam in a steam still, is it not?

A. I did not so interpret this. This may be used for that purpose, but I interpreted it that they wish to re-work some impure products carrying light petroleum, and to carry them through, and through this system of condensers with which the patent is largely concerned, and that by such they would cut them into exact fractions of more valuable commercial character.

Q. In either event, they would supply a considerable part of the partial pressure within the system, wouldn't they?

A. When they were introduced and if they were introduced.

Q. And their presence would reduce the evaporating temperature of the heavy oils and act just as steam does in a steam still?

A. Yes, and they would be fractioned off essentially without cracking, so that in that sense——

Q. And at the same time they would prevent the cracking of the heavy ends, just as steam would?

A. I don't see how they would prevent the cracking of [fol. 483] the heavy portions, because, if we introduce them, we will increase the pressure there, or the speed with which the products go through, and pass out through the valve, M—if M is kept at the same point—then we would, instead, increase the pressure in the coils, here, and thereby indirectly affect and increase the cracking of the heavier products, as well.

Q. We don't need to misunderstand each other about steam in a steam still. You stated that a steam still is pro tanto equivalent to a vacuum?

A. We were discussing, there, the atmospheric pressure stills, and that we could work them by running steam into the still, and we would get less vapor pressure, and would get the equivalent of a partial vacuum.

Q. And whatever the proportion of the pressure is composed of, steam might just as well be removed entirely, as far as the evaporation of the oil is concerned?

A. In a straight distillation, yes.

Q. And that is true, whether you are running at atmospheric pressure, or at a higher pressure—at any given pressure—the foreign gases, like steam, subtracts just its proportion from whatever pressure is in the still?

A. That is true when your steam is passing through the liquid, and is not simply above the liquid.

Q. Yes, and if it is introduced and went through this kind of a construction——

A. It would certainly serve to displace a part of the vapors and to decrease the cracking, because you had the space occupied by steam.

Q. And it tends to offset the pressure—pro tanto—whatever the pressure may be?

A. It gives its own partial pressure to the system.

Q. So that you could have a still running with steam, and under pressure, and yet have the equivalent of a vacuum still?

A. You would have to have ninety per cent steam and ten per cent oil, or something like that.

Q. It depends on how much pressure you have, of course?

A. Yes.

Q. But if you had twenty-five pounds pressure and half of your vapor is steam, you have the equivalent of a vacuum still, haven't you?

A. No, because you would have the twenty-first pounds, equivalent to forty pounds as absolute pressure, and this [fol. 484] would mean the equivalent of twenty pounds on the still, which would be more than atmospheric pressure of 14.7 pounds.

Q. Yes, I forgot that. If it was two-thirds steam, it would be equivalent to a vacuum. Now, when you are running a still of this type, and in order to get that kind of results, you can put water in it, and it will form steam and do just the same thing, wont' it?

A. Just the same thing as what?

Q. As the steam would. That is, you could introduce water into this type of still and get the same effect as if you put steam in it, direct?

A. Yes.

Q. And that has been regularly used in the pipe still, which is commonly used for distillation, hasn't it?

A. It could be done. I don't recall that it is, but it could be done.

Mr. Rauber: In other words, you mean under pressure?

Mr. Wiles: Not particularly under pressure.

Q. You are familiar—when I say pipe still, you are familiar with that type of still which is generally known in the art as a pipe still, and sometimes called the California pipe still, are you not?

A. I don't know it by those names. Possibly I know the apparatus.

Q. Well, I had in mind the type of a still where the oil is brought up to a temperature, in a long pipe like this Schuchow diagram shows,—although it is usually horizontal, and then straight into the separator drum, and the distillate taken off, and the residue and the distillate frequently separated by fractional condensation—the type of still that is most widely used in skimming California crude?

A. I have never seen it operated. I have seen items in the technical press regarding it, but I don't know any of the details of it.

Q. And you don't know that in that case they frequently introduce water in the oil?

A. I know that in the processes of skimming or topping, they do occasionally introduce water into the still.

Q. In fact, they very frequently find that two or three per cent of water in the still causes it to work better, do they not?

A. Yes.

Q. Now, when you introduce an excess of light ends, like [fol. 485] gasoline, or benzine, into your oil, you have just the same effect of increasing the evaporation at a given temperature, of the heavy ends, as if you had an equivalent amount of water vapor, or a volume of water vapor—isn't that true?

A. If you were using, possibly, a residue, yes, if you were using a crude oil, no. It comes in the case, here—if you were having a cracking process at those higher temperatures and would consider that your reaction, or cracking, is an equilibrium reaction, then the presence of gasoline, or kerosene, would increase the amount of cracking, to form gasoline, or kerosene. If, on the other hand, we consider it not an equilibrum reaction, then it would not give the same effect.

I don't consider that it is a proven case, whether the cracking process is an equilibrium reaction, or not—an equilibrium reaction in the sense that it can be reversed.

Q. Since you have brought that question up, and as I probably would have had to refer to it at a later time, anyway, I will ask you a few questions about it now, and then go back.

Have you an opinion on that subject, as to whether the mass action rules apply to this cracking reaction, in such a way as to practically affect commercial cracking operations?

A. Well, I know that there has been some work by which lubricating oils were made by cracking light oils, though with low yields. Yet, I am rather of the opinion that we cannot, at the present day, say that the mass action law can be applied to the matter in a sufficient way to per-

mit us to calculate before hand the results close enough to be of commercial interest.

In other words, while there has been some experimental work that is in favor of the mass action law applying, I question whether the reactions are well enough known.

I think we have no evidence that by treating carbon with hydrogen, or methane we can get an octalene, which would be the reverse of the equations that I showed in my first day's examination.

Q. In your opinion does the presence of gasoline in the reaction zone, have any practical effect on the formation of additional gasoline?

A. Are you referring, now, to processes in general, or to the Russian patent?

Q. Processes in general. You raised the mass action question, and I am willing to follow it for a few moments.

A. Yes, to the extent that it increases the pressure. If [fol. 486] you work at the same pressures, I doubt if it would be of any considerable effect—that is, that your yield would be changed to any large percentage.

Q. Suppose you maintain your temperature constant, will the presence of gasoline have any practical effect, in your opinion, on the formation of further gasoline?

A. Do you refer to gasoline in liquid or gasoline in the vapor phase?

Q. In the reaction zone, whichever phase it is in.

A. If it is in the liquid zone, yes, it will decrease it. If the vapor, there, was in the vapor process—well, if it is in the liquid phase process, I doubt if it would affect it.

Q. If it was in the liquid phase process, it would be out of the reaction zone, would it not?

A. There is a continued interchange between that which is in the liquid phase and that which is in the gaseous phase above the liquid phase.

Q. And you think that the presence of gasoline in the liquid phase in the reaction zone, materially and substantially decreases the formation of further gasoline?

A. It would act as a dilutant. It would keep the molecules further apart, and, as such, we would expect, in the first place, less action, because there are fewer pounds of heavy liquid present in the still, and consequently less would be formed from that.

In the second place, if the reaction was one—as most chemical reactions are—in which not a single molecule alone, enters in, then the presence of the dilutant would tend to lower it.

That, as actually carried out, the amounts of gasoline present here, are comparatively small, and the presence of these would not affect to any considerable percentage, the yield of gasoline from the cracking process.

Q. Then your view is that for practical purposes, the mass action principle, does not affect the gasoline cracking processes?

A. Yes, I say that in spite of the statement made in the patent to Palmer, where the inference is that the presence—by carrying out the digestion, there, the process will give larger yields and more of the cracked products.

Q. Now, returning to Schuchow & Gavrilow—by the introduction of these light ends of the crude oil or raw materials, would not the cracking be retarded by reason of the mass action law, if there is any cracking?

[fol. 487] A. It would retard it, inasmuch as the introduction of these benzine and gasoline products would decrease the amount of the heavy oil that was introduced, the percentage that would be cracked would be essentially the same. It might be changed, somewhat, but probably not enough to make a difference between the commercial successful and the commercial failure process.

Q. But the introduction of these light ends would necessarily have the steam stilling effect that we have discussed already, and carry away, without cracking, some parts of the raw material, and thus materially interfere with cracking, would it not?

A. Not in this case—because, in this case, we have our oil and our gasoline pushed up to the top, and all of it—both the liquid and the gasoline—passing out—the gas through pipe E, and the liquid through the pipe, D.

Your statement would be true if you were taking only off the vapor, say from the Dewar & Redwood process. But it is not true when handling this Schuchow & Gavrilow process.

Q. Isn't it true, in the case of a pipe still, that the presence of the steam greatly increases the evaporation and gives you a deeper cut?

A. But you are there getting another effect. We are getting, in that case, a spraying of it into the chamber, and an

evaporization. I think I should cancel that answer. I am not certain that I know enough regarding your pipe still, and your cutting scheme, that you mentioned, as I have never seen it, and all I know of it is what I have seen, incidentally, in references in the scientific literature, and I may be inferring things regarding it, which are not correct, and I think I had better not, for that reason, discuss it.

Q. If you take a still like the Schuchow & Gavrilow still, and attempt, with it, to do merely fractional distillation, without cracking, the introduction of benzine and gasoline. with the crude, will result in taking a deeper cut into the crude, than if you did not introduce it, isn't that true?

A. That is, you are, as I understand it, working with pipes of small sizes, in a large furnace, which are heated only to a moderate temperature, and not to a cracking temperature?

Q. Yes.

A. And that you are raising the question as to whether residue, used alone, as compared with the residue used with gasoline and benzine, would not give more heavy vapors, [fol. 488] carried over with the light vapors, through the valve, M, and the pipe, E. I think that is true—that you would get more.

Q. And that is because the presence of these light vapors contribute to the partial pressure in the still—that it tends to off-set, to some extent, whatever pressure is there?

A. For every cubic foot of vapors that would pass over, there would be a certain amount of the heavy oil, and if we increase that amount of vapors, we would increase, accordingly, the amount carried over, because we have increased the number of cubic feet.

Q. And furthermore, the presence of these light vapors, in proportion to their amount, will increase their velocity, of the entire stream, through the apparatus—is that not true?

A. That is on the supposition that these pipes are working at a temperature at which the light vapors are essentially the only ones which are available—that is, which are in gas form. On the other hand, if we would work—as this apparatus works—at decomposition temperatures—cracking temperatures—then the statement is only true to a very minor extent.

Q. In any case, the velocity is increased in proportion to the amount of the vapors, is it not?

A. Not in proportion. For example, if you put none in you would still have some velocity—not zero velocity.

Q. And if you put in a little you will get a very considerable increase in vapors, which will increase the velocity far greater than the proportion that they bear to the total—isn't — true?

A. A little, I presume, refers to gasoline?

Q. Yes.

A. And the total is what? Is it the total vapors, or the total liquid, or the total material, without the gasoline?

Q. Let me put the question again. Perhaps your picture of just the way these things work out, is not the same as mine. When you feed oil into one of these pipes, in a pipe still—this pipe still type of thing—at the beginning the pipe is full of oil, isn't it?

A. Yes, sir.

Q. And then you have only the velocity that the pump contributes to the flow of that stream. Presently, as the column moves along through the pipe, you begin to form vapors. That is correct, isn't it?

A. Yes.

Q. And in the case of normal oils, such as you may expect, [fol. 489] the oil, itself, expands at atmospheric pressure, somewheres in the order of 180 times, the moment it evaporates, doesn't it?

A. What is that number?

Q. 180?

A. That liquid changes to gas?

Q. Yes, into vapor?

A. At what pressure?

The Master: It is its volume of expansion that he is talking about.

Q. At atmospheric pressure?

A. That is it, approximately.

Q. Therefore, as soon as you begin to form vapors in one of these pipes, you get, not a dense column of oil, moving at the pump speed, but a volume of foam, or frost, the size of the bubbles in which is very rapidly increasing—that must be true—and as you get towards the end of one of these

stills, your velocity is necessarily very high, and your bubbles, by that time, have burst, and you have practically a stream of vapor, with spray in it—that is your condition, of necessity, in any still of this kind. Now, the presence, therefore, of a very small quantity of quickly evaporating material, will greatly increase the volume of this foam column, and the volume of the vapor, and accelerate the velocity all the way through, won't it?

A. Yes, if your oil, to start with, does not, itself, form gas.

Q. Yes, of course.

A. And is not in the cracking process.

Q. Well, long before it begins to crack you are going to get some evaporation, if you have these light ends, aren't you?

A. Certainly.

Mr. Clark: Your Honor, before Mr. Wiles proceeds, I would like to ask Mr. McKee if he will put into the record the results of the experiment which Mr. Neave asked him to make?

The Master: Describe the whole experiment, Doctor, and then give your formulæ of results.

The Witness: I have carried out the tests on various methods of determining unsaturatedness of hydrocarbons as suggested by Mr. Neave.

The methods used were the so-called sulphuric acid method; the second, the method of Allen, which he has given in the Aanalyst of 1881, which is one of the citations in record; the later Allen method as given in Allen's Commercial Organic Analysis of 1902 edition, using carbon bisulphide as the solvent, the iodine numbers; the Wijs method as given in Allen's Commercial Organic Analysis, Fourth Edition; the Hubl, as also given in Allen's Commercial Organic Analysis, Fourth Edition, the Hanus method, also an iodine method, which is given by the Bureau of Mines, Technical paper, No. 181 of 1917.

The data are given on the accompanying sheet and in this it is to be noted that the bromine number is the number of grams of bromine absorbed by one hundred grams of the oil, the iodine number is the number of grams of iodine absorbed by one hundred grams of the oil.

These methods are in the references which I have given, all, I think, indicated as only approximate methods. The results obtained vary with the method, so that, in general in indicating a bromine number of an iodine number, we indicate by what method it is given. It is not always the [fol. 490] same. In other words, an iodine number might be given, and after it, in parenthesis, the letters W I J S.

The sulphuric acid method is the oldest method and is today perhaps the commonest method. The method used at the present day is described in the Bureau of Mines Technical Paper, No. 181, on page 9, and consists in taking a bottle, which is commonly made and sold for cream testing, known as the Babcock, nine gram, cream bottle; adding five *cc* of the oil, then adding to that ten *cc* of strength (ninety-three per cent) sulphuric acid, agitating thoroughly but keeping cold, for fifteen minutes; centrifuging for about three minutes, adding enough sulphuric acid to bring the oil into the neck of the bottle which carries the graduations, and then centrifuging for ten minutes longer and then reading off the volume.

I said that the amount added was five *cc;* it is not quite five *cc.* We use a pipette which comes with the bottle, and is, strictly, 4.96 *cc,* but the graduations are in accordance with this volume, so that we directly read the undissolved oil and the difference between that and the volume taken is the per cent of unsaturates, and that is indicated in the first numerical column.

Of the materials here, the benzol, as given in this first column, is the one which is subject to the most irregularity, in the sense that it is hardest to carry out the experiment and get the same result again. The percentage obtained is more dependent upon the amount of shaking than it is upon anything else in that case; in the other cases it is not, to amount to anything, dependent upon the amount of shaking as long as there is a reasonable amount.

The old method, which is a somewhat obsolete method, Allen's 1881 Bromine method, is not now used. We have it described in "Petitioner's Exhibit No. 113", and results obtained from it, given on page 179 of that volume.

The results that I obtained from it are not the same, but it is true, of course, that the starting materials which we use were not the same.

In this scheme, as given on this second column, benzol ran much lower than is given by Allen in the article in the Analyst, on page 179. However, he states on this same page:

"Benzol does not give a satisfactory result, the re-action with bromine occurring slowly, instead of instantaneously, as is the case with the shale—" it says: "of petroleum products", which I think is a typographical error for "or petroleum products."

[fol. 491] The ordinary method in using this is, we allow it to stand for a couple of minutes. If we allowed it to stand longer, I found that the benzol value went up, and I presume if we allowed it to stand over night we would get a value perhaps as high as Allen has obtained; but using the standard time that was used for the other products, it only gives a low number for benzol.

The third numerical column is the process described in Allen's Commercial Organic Analysis, Fourth Edition, Volume 3, page 4, which is a modification by Allen of the Mills and Snodgrass method.

This method was described in "Petitioner's Exhibit No. 115", page 4, 5, and 6. In this method, the bromine is dissolved in carbon bisulphide; the oil and the carbon bisulphide both being dry; the two are mixed, allowed to stand for fifteen minutes, and then a potassium iodide solution added, and titrated with sodium thiosulphate. This permits us to determine the amount of bromine which has been absorbed, when titration is made with the same volume of the bromine solution in carbon bisulphide, and the difference between this blank and the titration of our unknown permits us to calculate the figures given in the third numerical column.

Passing now to the iodine numbers, the Wijs method is described and is one in which I have given the reference, and it is made by dissolving iodine in strong, that is, glacial ascetic acid running in chlorine until it is about the equivalent amount, then adding our oil, dissolved in chloroform, allowing it to stand for five minutes, then adding potassium iodide solution, some water, and titrating again with sodium thiosulphate. The calculation is similar to that given under

the bromine method, except the atomic weights for iodine are used instead of for bromine.

In the Hubl method, we have the use, instead of ascetic acid, of alcohol as the solvent, and in this case we dissolve our iodine in absolute alcohol and add to it mercuric bichloride dissolved in absolute alcohol. The oil is idssolved in a small amount of chloroform and the material is allowed to stand here for several hours. This is a slower one than the earlier ones which only have to stand for a few minutes. The potassium iodide solution is added and it is diluted and titrated, and then titrated with sodium thiosulphate.

The Hanus method, the data for which are given in the last column, is one which was not asked by Mr. Neave, but one which is used for just such purposes by the Bureau of Mines.

[fol. 492] In this case we dissolve the iodine and bromine in glacial acetic acid, allow it to stand for 24 hours, then use the solution. In other words, the solution must be made up at least 24 hours ahead of time. The oil to be tested is dissolved in chloroform; 10 *cc* of this mixed reagent is added, allowed to stand for 30 minutes; potassium iodine solution and more water added, and then a titration made with sodium thiosulfate to determine the excess of iodine or bromine.

In the various results, it will be noted that of these iodine methods in general, the Hubl method gives the somewhat lower results, and the Wijs method next and the Hanus method the highest results. The results for an iodine number are, roughly, 1.6 times the bromine number. They are not exact but only roughly.

In such analyses as these we do have some mechanical troubles. For example, in our material that we take, we use ordinarily only .2 of a gram or slightly more. ,2 of a gram is roughly four or five drops, so that we must make our weighing on four or five drops without a large proportion of evaporation if we are to get duplicating and exact results.

Some of the variations here, I think, are due to this variation and this difficulty of making exact weighings of your sample due to evaporation. The figures that I have given, in general, are of averages of at least two determinations

except in the Hanus column. That column reached a stage that by midnight last night where I stopped with one determination. That does not represent average of duplicate determinations.

The variations between samples is not large but it is perceptible. The figures given are not absolutely accurate but are as accurate as this kind of analysis ordinarily is; in other words, the method of analysis itself is subject to error, and it is for that reason, for example, that Allen in his later work discards his 1881 method in favor of the 1902 method, and he further indicates that for most compounds the iodine methods are probably more accurate than even his 1902 bromine method.

I think that completes what I wanted to say regarding the samples.

The Master: Do you want the results made part of the record?

Mr. Wiles: Yes, please.

The Master: The result of these tests will be spread on the record.

[fol. 493] Analytic Methods for Unsaturatedness of Hydrocarbons

Material use	Sulfuric acid	Allen's 1881 bromine number	Allen's 1902 brom. number	Wija iodine number	Hubl iodine No.	Hanus iodine No.
Benzol 80-82....	51 %	1.96	.5	.8	.6	1.3
Shale Gasoline..	53.8%	107.	64.	135.	130.	147.
Socony Gasoline.	16.	14.7	15.5	24.4	22.9	28.
70° Naphtha Special	12.5	3.3	2.9	5.3	3.6	4.8
Naphtha Benzol 5:1	27.5	2.8	2.3	3.7	2.9	4.1

Bromine number is the number grams of bromine absorbed by 100 grams of the oil.

Iodine number is the number of grams of iodine absorbed by 100 grams of the oil.

Q. Without attempting, Doctor, to cross examine at all about this table that you have just produced, because we want to study it carefully before going over it, there are one or two questions I would like to ask about it for our information in studying it.

What was the strength of the sulphuric acid used in the sulphuric acid absorption?

A. It was that which is sold by the J. T. Baker Chemical Company, and which is indicated on the bottle as of 93 per cent.

Q. Regular 66, pure acid?

A. Regular 66, pure acid, not commercial.

Q. Now, what was the source of the shale gasoline that you tested?

A. The shale gasoline was gasoline made at a small plant, experimental plant in New Jersey in July or August, and I received it in August, from Colorado shale; at least, I was told it was from Colorado shale. I did not see it made but I had this gasoline sent to me for another purpose, and I happened to have it in the laboratory when I became connected with this case.

Q. Have you some more of it?

A. I have here samples of each of these materials.

Q. Just the shale was all I was interested in.

A. (Sample handed to counsel by the witness.)

[fol. 494] Q. Is this shale naphtha or shale gasoline that you have just produced a fairly typical shale gasoline?

A. I did not see it produced there but I would think of it as a fairly typical gasoline, though it is made by what you might call "an abnormal process"; a process that has never been used, so far as I know, commercially.

Q. This sample is rather small to do much with. Have you got a fractionation of this?

A. Yes, I can give you the curve for it, I think.

Q. Yes, the regular——

A. The regular fractionation curve.

Q. If you do not mind, the Engler distillation.

A. I have had it, not on the product of which this is a part, but on that.

Q. Now, do you know how far along this particular product was, or what it went through? I do not mean the cracking of the shale, but what was the——

A. Chemical treatment?

Q. Well, after the crude shale oil came off, how did this come out?

A. This is from a series of partial condensers, so that this was from the last of the several condensers which are at-

tached directly to the shale retort, and was made directly from the shale and condensed. When the product came to me I was primarily interested in the nitrogen compounds, and asked for the product on account of that, and treated it with dilute sulphuric acid, six to ten per cent, or somewhere in that range, to pick out the nitrogen compounds. Then I set it aside and did not become interested in it again until this question was raised in con-ection with this case.

The product was purified for this by treating with a doctored solution; that is, a lead oxide in caustic soda, then with a small amount of about eighty-two per cent sulphuric acid, twice in each case, using about three or four per cent, using less than four per cent sulphuric acid. Then it was washed with water, then caustic, then distilled, and the product, I may say, has a rather low end point, as compared with 437° F. It is my recollection that it is probably around four hundred degrees, instead of four hundred and thirty-seven.

Q. Will you have that fractionation——

A. Yes, I have it. I think I did have a record of it and I think I still have.

Q. When was it that this treat was made, that you have been telling us about.

[fol. 495] A. You mean originally made, or the sulphuric acid?

Q. Let me see if we are together on this.

A. Yes.

Q. And see if I understand exactly the situation. There was a light fraction taken directly off the shale by a fractional condenser?

A. Right.

Q. And that crude material was sent to you without any treatment at the plant where it was made?

A. That is my understanding of it.

Q. That came to you last August?

A. Yes, about the first of August.

Q. About the first of August, yes. At that time you treated with about ten per cent acid to take out the nitrogenous compounds?

A. Yes.

Q. And set it aside, set the remainder aside, you being interested in what came out in the acid at that time?

A. That is correct.

Q. Now, how long did that remainder, that is, the treated oil, remain there before something else was done with it?

A. Until about two weeks ago.

Q. About two weeks ago?

A. Possibly ten days.

Q. Ten days about the first of November?

A. Yes.

Q. And then you made all this treat then about the same time, in one day; that you are telling us about, or within a day or two?

A. I think the distillation was the second day.

Q. I see. Practically right along.

A. It was meant to be all one day.

Q. About the first of November?

A. Yes.

Q. And in the course of that you treated twice with four per cent——

A. No.

Q. No, with four per cent of dilute sulphuric acid?

A. Of about eighty-two per cent of sulphuric acid?

Q. About eighty-two per cent strength of sulphuric acid?

A. It happened to be.

Q. Making a total of about eight per cent on the oil of eighty-two per cent acid in two dumps?

A. I think that is right.

Q. Then you washed——

A. With water.

[fol. 496] Q. And neutralized and doctored?

A. In this particular case I think we doctored before we distilled—before the sulphuric acid treatment.

Q. Then I have the doctor treats in the wrong order. You first treated with doctor?

A. Yes.

Q. Then a treat with eight per cent of eighty-two per cent strength sulphuric acid in two dumps?

A. Right.

Q. Then washed and neutralized and re-ran?

A. By "re-ran," you mean distill?

Q. Re-distilled?

A. Yes.

Q. To dryness, substantially?

A. No, there was quite a little bit of kerosene products present there and we simply cut at four hundred.

Q. You ran and cut to four hundred?

A. Yes. There probably was as much as one-half or one-third of kerosene products.

Q. That was the last thing you did?

A. Except to analyze it. That was the last thing to it.

Q. Well, this sample here that you have just handed me?

A. Yes, that is the last treatment that it has received.

Q. (continued). Is the distillate from that re-running after treatment?

A. Yes.

Q. And it has been now about a week old?

A. A little over a week old.

Q. A week or ten days old, somewhere in that order?

A. Yes. It had about the same color when distilled as it has now; slightly colored, as you notice.

Q. Do you know the color value of this now?

A. I have never measured the color value numerically.

Q. Compared with the seventy degree naphtha, it is now, as produced by you, distinctly off color, is it not?

A. It is distinctly colored.

Q. Yes. It would not meet water white specifications now?

A. No, but many gasolines on the market are more colored than the seventy degree naphtha.

Q. Yes, but would this shale gasoline as it now is meet water white specifications as construed, practically?

A. In going through the Handbook of Petroleum, Asphalt and Natural Gas by Cross, Bulletin No. 15, I find in [fol. 497] the twenty-eighth state requirements no specification as to color, so far as gasoline is concerned. I find such specification as to color in one gasoline only, and that is in aviation gasoline. I do find such specifications in the kerosene but not in the gasoline. In other words, water white seems to be a trade term, which is not a requirement for use.

Q. What is the reference?

A. The requirements for the states are given on pages 143, 144 and 145.

Q. Is it not a fact that large manufacturers of gasoline meet the Government or Bureau of Mines' specification, or better?

A. I would like to see a copy of your Mine specification. Have you it there?

Q. Yes. When I say "Bureau of Mines," I mean the one published by them, it is not their specification (handing document to witness).

A. That is what I thought, it was not their specification.

Q. This one I want to call your attention to, that I happen to have, is January 1922 as amended March 1922, and it has been somewhat changed since.

The Master: Is there not a specification by the Bureau of Standards?

The Witness: No.

Mr. Wiles: No. It is the specification the Government Departments use in their purchases and it is published in a Bureau of Mines' Bulletin from time to time. It is the Federal specification for motor gasoline, and it is generally followed, I think, by everybody, or better. I mean by that, all the big makers. It is frequently called "Navy Specification," because the Navy started the practice of publishing a specification.

The Witness: In the aviation it is said "that the color shall not be darker than No. 25 Saybolt." Cross, in this book that I have read, interprets that as water-white. In the motor gasoline, not the aviation. "The color shall not be darker than No. 16," which is apparently quite a different standard from No. 25, which is a water-white standard."

The Master: Does it define water-white?

The Witness: I do not find water-white defined.

Q. It identifies the method, does it not?

A. It is method 10.1.

Q. 10.1?

The Master: Is it designated as the so-called water-white?

[fol. 498] The Witness: I do not think so, your Honor. It does not define in this Bulletin, the method referred to, but a certain method is referred to against a standard material which is a colored material. Water-white kerosene, for example, is defined under the term "water-white kerosene. The color shall not be darker than 21 Saybolt." Where, with the gasoline, we are allowed 16.

Q. Now, will the sample that you have produced meet the 16 color, the sample of shale gasoline, I mean?

A. I do not know. I would think not, though.

Q. In other words, the sample as produced here, a week after treatment, is not, in your judgment, up to the specifications that the manufacturers actually meet?

A. I think it is; that is——

Q. I mean the color specification.

A. (continued). Up to the color specification, as manufacturers can and probably do meet for other than sale, say, to the Government, or to such specific bodies. For example, there are a number of state tests here, and it meets apparently all of them, out of the 28 states that have specifications.

Q. Do you not know that, as a matter of fact, all the big manufacturers of gasoline make a gasoline with a better color than the government requires, all the time?

A. Possibly. I have not checked up on those samples as to the running analyses for color of the gasoline. Color is of no importance as far as the use of gasoline is concerned.

Q. The Government requires it, does it not?

The Master: For what it buys?

Mr. Wiles: What?

The Master: For what it buys?

Mr. Wiles: Yes. Well, it must have a reason for it.

The Witness: Not always.

Q. Do you not know why there is a color requirement in gasoline in the Government specification?

A. It has been the product that they have had in the past which has met this color requirement, and they feel that they want to get, in general, what they have had in time past.

Q. Now, do you know that that is the reason?

A. That is one reason.

Q. What are all the reasons that you know of for manufacturers meeting a color test?

A. I do not know what the reasons back of the manufacturers meeting the color test are.

Q. Under what conditions has this sample of shale gasoline that you produced been kept since the re-running; that is, during the last week or ten days or thereabouts?

A. It has been kept in a glass bottle, out exposed to the light in the laboratory, such as it is now.

Q. Not in sunlight?

A. Yes, it would be in the direct sunlight for an hour or two in the afternoon; that is, through a western window; perhaps not more than an hour.

The Master: Now, there has been much examination about these matters. These ought to be marked and identified.

[fol. 499] Mr. Wiles: I want to measure the color on this right away by our own people, if I may.

The Witness: Your Honor, I think you might be interested in the question of the odor of shale oil gasoline (handing bottle to the Master). It is about like the ordinary. It is a little different but carries about three times as much in the way of unsaturates as the other gasoline does and has a somewhat different odor.

Mr. Rauber: These are all blanks, are they not?

The Witness: Yes.

Mr. Rauber: Of course, they would smell somewhat different than the straight run?

The Witness: Yes.

Q. Will you please tell us where and when you got this Socony gasoline that you have used?

A. The Socony gasoline was bought at 108th Street filling station, on 108th Street between Broadway and Amsterdam, on last Friday.

Mr. Wiles: Will it be satisfactory, your Honor, if we take this? We will have to pour it out of the bottle and back again, but we want to measure its color now and compare it with its color later. That involves merely—I am correct, I believe, in saying it involves merely pouring it into a long glass tube in which its color can be measured against a standard color and pour it back again.

Mr. Rauber: I doubt if you have enough to make a color test. Doctor McKee, have you enough to make a color test?

Mr. Wilson: I think we have just about enough to make the test with, just about enough. I can do that myself and testify with regard to what was done with that.

Mr. Wiles: I want you to do it, of course. We want only to take it for that purpose and return it.

Mr. Rauber: Could we get another sample of the same kind instead of destroying this exhibit? Have you another sample, Doctor McKee, of this same material?

The Witness: I do not believe I have. While I have some of the raw material, I have not any more that went through with this lot. It is like this sample that I asked for a pint of 70 degrees naphtha, and got only a third of a pint.

The Master: If the Government has no objection to you making a color test, I have not.

Mr. Rauber: I would rather get a larger sample so that we can have a color test made of the same material. I see no reason why we should take this particular one.

[fol. 500] Mr. Martyn: May it please your Honor, I suggest that the machine could easily be brought here in the court room and the sample tested here.

Mr. Wiles: I just want a record of it as it is now. The question is whether these are stable or not. I would like a colorometer reading of this now and we will see in three months whether it is the same.

Mr. Rauber: I think you misunderstood Dr. McKee on that.

The Master: In order that there may be no controversy about it, perhaps you had better bring your instrument here and make your tests here in the presence of the attorneys for the petitioner.

Mr. Wiles: Very well, your Honor. Now, so far as this color matter is concerned, I think I have gone as far as I care to, but on the other matter of this table I shall want to go into that more fully, and in connection with that I want to call your Honor's attention to the fact that of the 30 determinations the witness has made and brought here, Mr. Neave asked for six; the remaining 24 are volunteered by the witness.

The Master: Well, they may well be put in as——

Mr. Wiles: Oh, unquestionably.

The Master (continued): Comparative and as within the question asked for.

Mr. Wiles: I am not objecting to them; I am raising the question——

The Witness: I think you are wrong, Mr. Wiles.

Mr. Wiles (continued): —as to my right to fully cross-examine on them.

The Witness: I think you are wrong, Mr. Wiles. He asked for benzol, for 70 degree naphtha, for naphtha-zenzol mixture; he asked, as I recall, for the sulphuric acid and the Allen's 1881 treatment, and the Allen's 1902 treatment, and then he afterwards asked for the Hubl. I am not absolutely certain about the sulphuric acid, but he certainly asked for the 1881 bromine method, the 1902 bromine method and the Hubl, so that would be more than what you indicated. And it is the Hubl method that takes the time.

Q. Now, have you the data that I asked for yesterday as to twine oil calculations?

A. Yes. I last night went over and corrected in using the A. P. I. bromine for the Aisinman and for the Riebech oils, and give them here to you in the accompanying sheet.

[fol. 501] Calculations Using Burton's Equation

$$.51x^2 - 106xy - 961x - 29y^2 - 244y - 53296 = 0$$

Where x is Saybolt Viscosity and y is Baume Gravity

Aisinman's Oils

			Saybolt at 100° F.		Discrepancies	
Sp. G.	Be.	Engler	B. of St	Battle	B. of St.	Battle
.800	45.38	2	64.6	50	126,564	69,909
.800	45.38	4	134.9	72	403,794	155,374
.900	25.72	2	64.6	50	37,254	10,899
.900	25.72	4	134.9	72	168,984	51,264
.905	24.85	6	204.1	93	285,222	82,764
.905	24.85	10	341.6	135	553,942	158,042
.930	20.65	6	204.1	93	201,294	48,334
.930	20.65	10	341.6	135	407,514	104,414

Riebeck's Oils

.93	20.65	7	239	105	252,140	63,725
.93	20.65	10	342	135	408,934	104,304
.95	17.45	7	239	105	174,790	32,463
.95	17.45	10	242	135	296,762	60,132
.912	23.65	2.5	82.2	58	55,052	16,119

The first column represents specific gravity, the second column is the transformation of that specific gravity into

Baumé of the A. P. I. system. The third column represents the Engler degrees given in the citation. The fourth column represents the transformation of that into Saybolt degrees at 100 Fahrenheit, as is mentioned in the Burton patent, according to the Bureau of Standards table, which was discussed yesterday.

The fifth column represents a similar transformation but not by a Government authority, but by an oil industry authority, Battle.

The sixth column, and the next to the last column, gives the discrepancies when the Burton equation, given on the second line of the page, is calculated out and the difference betwen the zero that it should give, and the actual figure obtained.

The last column, the seventh column, is the similar discrepancies when calculated using the Saybolt figures as obtained in the transformation curve, as given by Battle. These figures, of course, in no case come out zero, as they would if the product thoroughly met the Burton specification, but the oils which Burton himself says in his patent, [fol. 502] meets his specification, did not come out zero either. They miss it by a considerable number of thousands. So that these figures, for example, some of them, are closer than his own figures, as given in the patent, for a product which he says meets his specification.

The Master: What I would like to know is, operating on the Burton process, by which he gets the product stated in the eqnation over a period of operaiton say a week's run, or the ordinary forty-eight hour run, samples being taken at different times, would they all be identical with the equation?

The Witness: No. In the very case that he takes, page 2 of his patent, a typical series of fractions, line 6, he gives the gravity and the Saybolt viscosity, and when you figure them out they miss his equation by more than eleven thousand, some of them plus and some of them minus, but one of them misses it by more than eleven thousand below his equation.

Q. Now, you just stated, I believe, that some of these figures were closer to the equation than the specific examples given by Burton. That is not true when you use the Bureau of Standards' method of translation, is it?

A. No, you are correct, that all of those of the Bureau of Standards' scheme of translation are somewhat further away. It must be borne in mind, however, that at the time that Burton patent issued, we did not have this method of transformation, and we did have the Battle's, so that at that time, using it for that period, we would have that as the normal scheme for translating one into the other.

Q. Well, if Burton had had one of these old oils, such as the Engler oil, and wanted to see whether there was any difference, he would have actually put it in a Saybolt viscosimeter, would he not?

A. Yes, but nobody else could, because the Saybolt viscosimeters were not available; had not been available. About that time they became available, just about that time.

Q. Yes. And then atural thing for anybody to do would be to test it—for Burton to do would be to test the real Engler, the real Reibeck, or Aisinman's oil in a Saybolt viscosimeter and see whether it actually met the conditions.

Mr. Rauber: What is that question again? You say "the proper thing for Burton to do?"

Mr. Wiles: Yes, in seeing whether he had a new oil, was to take the actual, physical oil, and test it in a viscosimeter.

A. I do not know how he would get Riebeck's oil, when Riebeck had been dead probably for twenty years.

[fol. 503] Q. Well, had it been available, that would have been the thing to do, would it not?

A. Yes.

Q. Test them both?

A. Yes.

Q. And the Bureau of Standards is the best method that we know of for translating from one viscosimeter to another?

A. Yes, but it is to be remembered that at the time that Burton carried this out, that the Bureau of Standards was not in a position to do this, and that in fact the Saybolt viscosimeters did not agree among themselves.

I quote from page 22 of Bureau of Standards' technical paper, No. 112, 1919:

"It has previously been impossible to determine whether a Saybolt viscosimeter gave normal readings, as neither

the dimensions nor normal times of flow for any given liquids were known. Now that these data have been determined, limit gauges have been prepared and the Bureau of Standards is now in a position to certify whether or not a given instrument is of standard dimensions.

Washington, February 3rd, 1919."

The Master: I may have asked this question before, but it seems to me important to know: Whether or not one pursuing the methods of the art prior to Burton's patent might innocently produce a material corresponding to the equation of the Burton patent?

The Witness: I feel very certain that an attempt to carry out, for example, the Dewar & Redwood process, or the Pielsticker process, or the Barbet process, and taking that residue and distilling it at atmospheric pressure afterwards; that is, taking the residue left after getting gasoline and distilling at atmospheric pressure afterwards, as was the common habit and as I quoted from the book of Crew and others, even in the earlier days, would get exactly that product. You start with the same material, you use the same process, and it would be very queer if you did not get the same product.

Mr. Rauber: Your Honor, I think in regard to that question I would like to recall to your mind that Burton himself, in the file wrapper of this twin oil patent, says or admits that he gets the same product by a patent that was patented before he filed this application, one of his own patents. That may have some bearing on the question.

Q. Now, your position in your last answer, as I understand it, and as I understood you yesterday in discussing [fol. 504] the Kittle process, also is that all of these old prior cracking processes produce essentially the same residuum, is that correct?

A. Yes, and no. No, if they are vapor phase processes; no, if they are carried to a greater extent in amount, say, to approximately complete dryness, there would be no residue in such a case.

Yes, when they carried, as in general Burton did, with the oils of ordinary type, such, for example, as the Pennsylvania oil under pressure, of approximately four or five atmospheres, and under the ordinary cracking temperature under those conditions.

Q. What I was trying to get at, in the last question, Dr. McKee—and, perhaps I didn't state the thing as clearly as I should have—was this: Is it your opinion that the pressure distillation processes of the prior art, particularly Dewar and Redwood, Riebeck, Young, Pielsticker, Laing, and Schuchow, would produce essentially the same kind of residue?

The Master: I would like to know something about that word "residue".

Mr. Wiles: Well, all right—I will say residuum.

The Master: If you mean by residuum, what is left over——

Mr. Wiles: Undistilled, in the still.

The Master: Then, necessarily, residuum depends upon how far and to what extent you carry on your reduction—doesn't it? It is not a fixed term at all.

Mr. Wiles: I think there would be a variation.

The Master: You are using it here as a fixed term.

Mr. Wiles: Well, I am assuming, of course, that in all of these processes the thing is carried to a proper commercial extent.

The Master: It might be carried to a proper commercial extent without being carried to a complete, final extent.

Mr. Wiles: That is true.

The Master: Now, in asking this question, do you mean a process carried to the complete and final extent to which any reduction can be made, until it has reached the coking stage?

Mr. Wiles: Oh, no, your Honor, because you don't run pressure still processes that far. There wouldn't be any residuum, if you did. You would have nothing but coke.

The Master: Of course you would have differing oils, depending on how far you carried your reduction—isn't that true?

Mr. Wiles: Well, I don't know just how far it would go. These things are not so easily predictable as you might [fol. 505] think. That particular question I have not investigated very thoroughly, but I would like to have the witness' view on it.

The Master: Let the question be read, and with an understanding as to what is meant by it, perhaps the witness can throw some light on it.

(The Reporter read to the witness the last question above.)

A. If they started with the same oil and carried the distillation to the same degree—we will say two-thirds, and one-third remaining—I would expect to get the same thin syrup-like product that Burton describes, also in the prior art patent, applied for August 25, 1913, being United States patent, No. 1,105,961, in which, on page 1, column 1, line 52, it is said:

"This method of distillation——"

"Meaning by "this", the pressure and temperature——

"—is continued until the residue in the still is reduced to a thin, syrup-like consistency, and the original charge has been reduced from thirty to forty per cent of its volume."

The Master: That is quoted from patent, No. 1,105,961—the Burton patent?

The Witness: Yes, sir.

Mr. Wiles: If the Court please, I wish to object to the witness' characterization of that prior art. That involves a question of a legal nature, which I don't think the witness is competent to decide.

The Master: Oh, well, he can call it a dog, as far as that is concerned; it makes no difference.

Q. Now, taking these processes that I have enumerated, and running them, as you understand from the several patents, they were run, and on the several stocks that they ran on, as you understand them from the patents—did they produce essentially the same kind of residuum?

Mr. Rauber: What do you mean by essentially the same kind?

Mr. Wiles: I will strike that out. I will say the same kind—and I wish, first, you would compare them with each other, rather than with Burton, as among themselves, as to the residuum of the same kind.

Mr. Rauber: That question, I think, is too indefinite.

The Master: I don't know whether it is or not. The witness knows whether it is indefinite or not. I don't know enough about the art to say whether it is or is not indefinite. Do each of these patents describe the residuum?

Mr. Wiles: Most of them do not.

[fol. 506] The Master: Then, how do you arrive at what his residuum was?

Mr. Wiles: Most of them describe their stocks and their temperatures and I want to know whether those residuums are alike. Burton may have made the greatest invention in the finding it. I want the witness to tell me—if you can predict——

The Master: Predict? What do you mean? Do you mean whether he can definitely say, by some sort of chemical knowledge——

Mr. Wiles: Certainly.

The Master: From the factors given and the stock given, that the residuum left in the still would be a certain thing?

Mr. Wiles: Yes, your Honor.

The Master: Do you think you can say that?

The Witness: I can, in part, and I think my answer, in general, will be yes—though it will not be quite an unqualified yes—that is, that they will give essentially the same residuum.

Young, operating on a Scotch shale oil, if he carried his distillation to about the same extent—that is, one-third residue—would get a product quite close to the Burton product.

Dewar & Redwood, operating on an American petroleum, which was what they mentioned particularly, at that date, and we would understand, probably, that it was a Pennsylvania petroleum—if he would carry out, essentially the same process, and on the same material, he would obtain, approximately, the same product as the Burton product.

Schuchow worked on Russian oils, and I don't know enough regarding them to be able to say definitely. Their supposedly high naphthene content would be an element entering in, and, accordingly, it would depend upon whether the amount of straight chain hydrocarbons rather than the amount of ring hydroclarbons, was the dominant one, and that would determine as to how near the products formed there——

The Master: That is, the residuum?

The Witness: The residuum formed—would be. I am inclined to think that our variation, here, would be due—if there is a variation—entirely, or approximately entirely, to the difference in raw materials.

If the Pielsticker's process—"Petitioner's Exhibits No. 133, and 134", were operated at the same pressure at which Burton operates—and Pielsticker does not state his pressure, but states it can work under pressure—in the year of 1891 and 1892, and considering his United States patent [fol. 507] particularly, if he was operating on the same oil as Burton, he would have the same type of residuum, because the raw material is the same and the process is essentially the same.

Laing, in his operations, cracking under a pressure of eighty pounds—and I am referring now, particularly, to United States patent, No. 471,291, of 1892—and condensing at atmospheric pressure, if operating upon the same materials as Burton—as he probably would, in operating his United States patented process—would get the same type of residuum, for his process is essentially the same, so far as the residuum is concerned. His condensing under atmospheric pressure would not determine, or change the character of the residuum product.

In general, these processes——

Q. How about Riebeck? I asked about him.

A. Oh, yes. Riebeck states that he operates on petroleum at four atmospheres pressure, and at a temperature of four hundred degrees Centigrade, which would be 752 degrees Fahrenheit—would get a product whose composition would depend upon the oil used—whether it was the Russian oil or the German oil or the American oil—that would determine, to a considerable extent, the character of the residuum. It would be subject, accordingly, to the same limitations as the Schuchow citation.

Q. But can you answer on the actual stock disclosed by Riebeck?

A. Riebeck says: "The process heretofore employed for the distillation of heavy, dark petroleum oils, brown, coal tar oils—crude petroleum, or residues from the refinement of the latter, or of the tars obtained in the preparation of oil gas, from paraffin oil, or petroleum residues"—if those words describe the raw material he is supposed to use in his process——

Q. He gives some specific examples, does he not?

A. He gives specific examples, but——

Q. Well, that is what I am inquiring about. Those are definite.

Q. He gives specific examples on the second and third pages of the translation of the patent. He does not say, however, from what source the raw materials used, was. He does say, however, that in one case he used dark, heavy paraffin oil of 0.912 specific gravity, and at 17.5 degrees C., had a viscosity—according to Engler—of 2.5.

I do not feel that this is sufficient to tell us the source of this oil—that is, the composition of it. The fact that it was [fol. 508] a dark, heavy paraffin oil would imply that it was not an American oil of that date, because, in 1886, when this was published, the Pennsylvania oils were the principal ones, and the Pennsylvania is a light, not a dark parafin oil, and it is also light in weight, and not a heavy oil.

He says, "This decomposition product"—well, he was referring to the distillates. Then, later on, on page 3 of the translation, he mentions an Alsatian petroleum—p-e-c-h-e-l-b-r-o-m-n—which gives more illuminating oils by 15.32 per cent, then usual distillation would give, this being about ½ more than the usual yields.

He states in the claim, that he "can produce light hydrocarbon, benzine and illuminating oils, and, simultaneously, viscous illuminating oils,—or, asphalt like oils, from heavy, dark, or light colored kerosene oils—brown, coal tar oils—crude shale oils and petroleum,—residues from the refining of crude naphthas, from the tars resulting from the preparation of oil gas from kerosene oil, or petroleum residues, and from all other mineral oils."

It is possible that the heavy, dark kerosene oils are mentioned as the first part of the patent, refers to these brown coal tars, as the wording is the same in this introductory sentence and in the claim. Accordingly, it is impossible, I think, to say just what oil he started with, though it may have been a brown coal tar oil that gave this product here, although it may have been, at other times, some other petroleum.

Q. If it was a brown, coal tar oil that he started with, then would you say that the residuum resulting, would be the same as in the other prior art patents that you have discussed,—that is, that I mentioned in this list?

A. I am not familiar with brown, coal tar distillates. Your original question was when they were carried out, distilling down to, say thirty or forty per cent, what I would expect to find from them, and I would say, in this case, that if we used the same raw material——

Q. That wasn't what I asked. My question was as to the actual stocks which they did use, how would these residuums resemble each other?

Mr. Rauber: They used various stocks—all kinds.

Mr. Wiles: Not all kinds, by a long ways, but with the stocks that they used and disclosed, would these residuums resemble each other, or not?

Mr. Rauber: Resemble to what extent? I think the question is entirely too indefinite.

[fol. 509] Mr. Wiles: Would they be the same general type of oils?

Mr. Rauber: The same general type?

Mr. Wiles: Yes.

A. It is to be noted that when we check the Riebeck figures and figure them out, and get the equation discrepancies, they are less than the discrepancies in the Burton figures, which he gives on page 2 of his own patent—oils made from California crude petroleum and oils made from Kansas and Oklahoma crude petroleum. That is, the residues from the brown, coal tars, are much nearer than the common American petroleum oils, given by Burton.

Q. Now, going to this table of yours—you didn't give me what I asked you for yesterday, did you—the data on which you made the calculations that you based your direct testimony on?

A. I did, excepting that I have corrected them, here, for the A. P. I. Baumé, instead of the Bureau of Standards Baumé, which I had used previously.

Q. Well, you have changed them in many respects, on this table, from the figures which you used in calculating for your direct testimony?

A. I have not.

Q. Well, you changed 10.53 to 17.45, for instance, didn't you?

A. But attention was called to that, and that correction was made yesterday.

Q. You made that on this table?

A. Yes, sir, I made that as a correction—to the A. P. I. specific gravity, instead of the regular Government Bureau of Standards, Baumé.

Q. Did you find, when you looked at your data, on which you based your testimony in direct, that you had used the figure 10.73, which you gave in direct, or that you have used some other figure?

[fol. 510] A. I have used the 10.73, as I stated yesterday.

Q. That was a tremendous error, and away beyond the changes from the two Baumé tables, was it not?

A. Yes, but that was corrected yesterday.

Q. You did not correct the calculations from it, did you—you just told me that it was an error.

A. Well, that would make an obvious conclusion, that that typographical error carried through, would mean an error in the result.

Q. And a very large error?

A. Yes, but still the product obtained is much closer, very much closer to Burton's equation, than the oils which he gives as typical oils of their art, as if those were the residue products, which they are not.

Q. You are perfectly sure of that fact, are you?

A. Yes, sir.

Q. You also added to this table one oil that I didn't ask you about yesterday, and that you did not testify about in your direct testimony, at all—that is a fact, isn't it?

A. I understand you to ask me to present the data that I had on the Riebeck oils and on the Aisinman oils.

Q. On those oils which you discussed in your direct—and you didn't say anything about this last Riebeck oil, in your direct, at all, did you?

Mr. Rauber: It was the Riebeck oil that you asked him about.

Mr. Wiles: He talked about two Riebeck oils, and now he has brought in a third one. That is a fact, isn't it?

The Master: Well, what of it—suppose he has?

A. They were in the citations that I gave. I had the calculations. I, perhaps, didn't give all the figures that I had.

Q. And the one which you have added is not a product of the Riebeck process, but is a Riebeck raw material, is it not?

A. But the Burton patent is for the product.

Q. Just answer the question, please—it is the Riebeck raw material, and not the product, isn't it?

A. That is correct.

Q. And it comes closer to the Burton patent than any of the others that you testified about in direct, doesn't it?

The Master: That so-called raw material is not a crude, but, is itself, a residual, is it not?

The Witness: Possibly.

Mr. Wiles: I don't think so. It is my impression that it [fol. 511] is this heavy paraffin oil—this brown, coal tar oil, that he talks about.

The Witness: No, I gave you an Aisinman figure of the oil which had a specific gravity of .900, and an Engler viscosity of 2, and I stated that it carried—I am speaking, now, of my direct examination—according to the Battle and the Bureau of Standards, each—it varied only eight thousand from the Burton formula. The new data, using the A. P. I. data, makes it a little further—10,899—which is very much closer, of course, than the oil which you referred to just now—16,000—and is closer than Burton's oils, any of Burton's oils, which he says meet it—and I refer to the oils mentioned in lines 11 to 25, in the Burton patent, No. 1,167,884, which is, I believe, what you call the twine oil patent.

Q. Now, it is a fact, isn't it, that in every one of those cases, to get an approximation to the Burton product, you have switched the ends of the series given in these references—that is, where you should have associated the heavy oil with the thick ends, you have, in all cases, reversed the ends of the series, and associated the heavy oil with the thin end—that is the fact, isn't it?

A. That is not true, I have given them both ways—all the oils. For example, the oil of specific gravity, .912, and Engler viscosity, 2.5—which is the only one that is absolutely certain—I have given that only the one way. Those which were uncertain, I have given both ways, so that you could take your choice from the readings, if you wanted to.

Q. Well, you did not, in your direct testimony—in all cases where there was an upper and a lower limit given—of weight and thickness—in your direct, in every single case—you associated the heavy oil with the thin end of the viscosity scale—didn't you, in every case?

A. I had them figured both ways. I gave those that were nearest to Burton and I gave the smallest discrepancy between that and Burton.

Q. And to do that you switched the end of the series?

A. No, I don't say that I switched the end of the series. What do you mean?

Q. You have stated, repeatedly, that in oils of the dark series, the heavy oils are thick and the light oils are thin?

A. I did state that as a general rule, but not as universal.

Q. You stated, yesterday, that you knew of no hydrocarbon oil that did not follow that rule, didn't you?

[fol. 512] A. In some series. Don't forget to put in that limitation, because that means a good deal here, and elsewhere.

Q. And in the Burton patent, involved here, the heavy oils are thicker and the light oils are thinner, aren't they—in the table of Burton's own oils?

A. In the illustrations he gives for what he calls his new product, that is true, but it is not true, if you make comparison with what he gives just below.

Q. Now, when you took the prior art, in order to make the approximations that you made in your testimony, the only ones that you called to the Court's attention, you, in every case, associated, did you not, the weight of the heaviest oil with the thinness of the lightest oil, and from that made your calculations, isn't that true?

Mr. Rauber: Where do you get the basis for that statement?

Mr. Wiles: I am asking him whether that isn't so?

A. That is true, because I was giving those which came nearest on that. And that is true, here, in the table I gave this morning, where I give it both ways, and you have the opportunity of taking the figures which are of particular interest, and the ones which are of particular interest, would, of course, be those which come nearest to the Burton product, and Burton's specifications.

We could have picked many other oils, such as Burton, himself, has picked, which do not come within that specification, but if we take those which are nearest,—and it only takes a description of one or two, of course, to be of interest, when it comes to the validity of a patent.

The Master: A person skilled in the art, and particularly in the processes described in the prior art, might do the same thing, might he not?

The Witness: Yes, sir.

The Master: He could associate the heavier with the lighter viscosity?

The Witness: He might, or he would probably take a single oil and determine it. Here the men said that the range was between certain things, and consequently we presume that the oils, here, had a viscosity and specific gravities indicated by the citation.

Q. Now, Dr. McKee, you read this Burton patent, and it contains a table, doesn't it, which gives the relation between the weight and the viscosity of the several oils that Burton claims to be new?

A. Yes, sir.

Q. And for each of the weights and gravities given, there is a certain viscosity associated with that particular gravity, isn't there?

A. Yes, sir, and when you figure them with Burton's equation, they don't agree.

Q. Now, wait a minute. I am not asking about the equation, at all. The table, there, refers to physical oils, and gives definite physical properties—weight and viscosity,—doesn't it?

A. Yes, but it must be borne in mind that the question of the viscosity was not a standard, there—that is, two Saybolt instruments would not agree, even among themselves.

Q. Not exactly agree?

A. Not exactly, and not by the principal testing means.

Q. At any rate, by the best means known to Burton, and to the oil industry, the one in common use, Burton did attempt to give the best way he could, certain specific physical properties of these oils?

A. I wouldn't say that it was the best, but it was a common method—but not the best.

Q. And he associated a particular gravity with a particu-
[fol. 513] lar viscosity, in each of these dozen, or more oils that he gives in his table—that is true, isn't it?

A. Yes.

Q. Then he states, in the patent, in substance, does he not, that the best way to illustrate that relation is to plot the curve of the gravity and viscosity relation?

A. Yes, page 2, line 107.

Q. And any man with the slightest knowledge of drawing curves, can plot that actual, physical curve, that will graphically show the relations that Burton was trying to bring out, can he?

A. He can.

Q. Did you plot such a curve?

A. No. He says, "This curve I find to be, in general form, a conic section, the approximate equation of which is"—and it is easier to work from such as equation than such a curve.

Q. You did not plot the curve?

A. I did not plot the curve.

Q. Now, Burton also says, in his patent, that that curve can be approximately defined by an equation, which you recognize to be the analytical equation of a conic section?

A. I didn't recognize it. I take his word that it is.

Q. As a matter of mathematics, isn't that type of curve a conic section? Using conic broadly, of course—not a regular cone.

A. Yes,—not a regular cone.

Q. But it is what is called, in mathematics, a conic section curve?

A. I presume so.

Q. Now, did you solve that equation and plot the equation of the curve?

A. Say that again.

Q. Did you solve the equation and plot the equation of the curve?

A. No, I plotted no curves.

Q. So that you don't know how close, actually, the curve of the equation falls in the graphic illustration, to the actual points given?

A. It would depend altogether upon the scale in which you have it—as to how you were to choose it, but it must be borne in mind that when he defines his process in brief

words—for example, in what he calls his first claim, he defines it as an equation, and not as a curve.

[fol. 514] Q. But that equation means a curve, to one skilled in mathematics, doesn't it?

A. Not as he defines it here—"as a new article of manufacture, petroleum oil, characterized by the following approximate relation between its gravity and its viscosity." No mention is made of a curve.

Q. Can you suggest any way that a man could describe an actual curve that he wants to describe in a patent claim, except by an equation?

A. I am not a patent counsellor, and I——

Q. Well, do you know of any way that you could write it in words—if we wanted to describe such a thing as a curve of a conic section, how else could we do it?

A. Palmer has shown a curve as part of his patent.

Q. And referred to it in the drawings—he put one in the drawings and then referred to it?

A. Yes.

Q. And it would come out just the same, if you did the other—it would mean just the same thing to one who knew how to read an equation?

A. I, frankly, can see no relation to a conic section, in oils. There is no form to oils, and this question of putting a shape to oil is something that is entirely new to me.

I can see how you could put an equation on here, and say that it, possibly, may be like a conic section, but all equations having two powers—that is, X, and Y square and X Y,—must necessarily be some sort of a conic section, if they are translated into space geometry.

But that doesn't mean that this equation, when it is put into the same place, there, means a conic section.

Q. Doesn't the patent say that it is a conic section curve, and was derived from a plot?

A. I don't understand that he says it was derived from a plot.

Q. How else could it have been derived?

A. I doubt whether you could give these figures to somebody else and ask them to plot a curve corresponding to them—to get an equation corresponding to the curve which they would plot—that they would come out, at all, with this same equation, because the errors of measurement, here, would be so far that he wouldn't have such numbers as 961.

Prior to the resumption of the Hearing, Mr. Wilson and Dr. Dean made color determinations with the chromometer, to determine the color of the sample referred to on page 1460 of the record and following.

Mr. Wilson found a color determination of minus five or six and Dr. Dean minus two and three-quarters.

Q. On page 372 of the printed record, you were asked whether certain disclosures answered to the description contained in the question which is a quotation from Claim 3 of this Burton twine oil patent, No. 1,167,884. In answering that question you gave the Aisinman reference. Is that the best reference you have for that description which was read to you at that time?

[fol. 515] A. It is yes and no on that. I was asked to give a petroleum which would meet that in my own mind. I had at that time two references primarily in mind, the Riebeck and the Aisinman. I gave one, which is one which meets it fairly well, and I gave only one. I do not know that I, at that time, thought it was better than the other reference.

Q. Well, have you changed your view as to it being better from the time you testified on direct?

The Master: What is that question?

(Question repeated by the stenographer.)

A. I am now inclined to think that it is a better reference than the Riebeck reference.

Q. Now, in the question which was put to you at the bottom of page 372, which was a quotation of the Burton claim of this twine oil patent, appears the statement that the oil has a Baumé gravity varying approximately from 20 degrees to 10 degrees, and a corresponding viscosity ranging approximately from 50 to 200. Do you not understand from the word "corresponding" that the 20 degree oil has the 50 viscosity and the 10 degree oil the 200 viscosity, and does that not check with the table in the patent in which those same figures are ascribed to the different samples of the oil?

A. I only understand that your statement is true in a rough way, and if you will note that above, in almost the exact middle of that page, the heavy oils with gravities of 905 and 930 do not come so close, the closest being 42,000, which is for the 930 and 6 degrees; and the other one for the 905 and 6 degrees.

In other words, I am using the six there with both because it was not shown in the——

Q. Now, I did not ask at all about that. I asked if you [fol. 516] did not understand that the word "corresponding" in the Burton claim meant that when Burton was talking about his own oil, the 20 degree Baumé oil had the 50 viscosity and the 10 degree Baumé oil had the 200 viscosity; is that not the fact as set forth in the Burton specification about his own oil?

A. Approximately so in the specification.

Q. And that is the way you understand the word "corresponding" in the claim, is it not?

A. Yes, roughly, as I said a moment ago.

Q. Now, the reference which you cited is the 20 Baumé gravity, is it not; page 372 that is of the printed record?

A. Yes.

Q. And that oil which you cited as your best reference has a viscosity, depending upon how you convert it, of from 135 to 300?

A. That is correct.

Q. Is that not the fact?

A. It is, but that is dependent upon the question of the Saybolt instrument and its variations, and we do not know but what Burton, for example, here was using a Saybolt instrument that gave very low viscosities or very high. It was an imperfect description.

Q. But your reference that you cite says that the oil of the prior art has a Saybolt viscosity of from 135 to 300 depending upon how you convert, does it not?

A. Yes.

Q. And when you convert by the Bureau of Standards method the figure is 300, is it not?

A. Yes.

Q. Then this oil of the same Baumé gravity, 20, as one of those specifically mentioned in the claim, is from nearly three to six times as high in viscosity as the corresponding Burton oil with the same gravity, is it not?

A. (Referring to documents.)

Q. Just answer the question.

A. I want to look up the reference here for a moment.

It is, roughly, two and a half, which would be perhaps nearer than three.

Q. Now, the prior art which Dr. Burton sets forth in his own patent contains, under the table of prior art oils, California petroleum, two oils of approximately 20 gravity; that is, one 20.4 and the other 20.6, which are just as close as [fol. 517] this Aisinman thing as you have cited, are they not, providing you use the Bureau of Standards conversion that you have testified was the best one, on Aisinman?

A. It is if we consider only that oil; if we make our corrections as we did yesterday in accordance with the table, changing the table to agree with the A. P. I. gravities instead of the Bureau of Standard gravities, we have in these Aisinman ones still closer ones, of course. They are still in the Aisinman reference.

Q. When you say that you refer to the two oils which you call Aisinman oils, which are the two last ones in your table that you produced this morning; that is, the two that have a gravity of 20.65.

A. Is that a statement or a question?

Q. Yes, I am just asking you that. You did refer to those, did you not?

A. No, the one that is nearest is the one on the third line, which comes——

Q. I am not asking you about the formula. You misunderstood me. I am asking you about the ones that correspond to that 20 Baumé gravity in the Burton claim.

A. You are limiting it entirely to the——

Q. To the one example.

A. (continued). To the one example of Aisinman, rather than the Aisinman reference I have given?

Q. To the one you were talking about in your direct testimony, which you said had a 20 gravity.

A. My answer was that the Aisinman reference gives oils corresponding to the definition which you have just given, for example, one that——

Q. All right. Now, the only one of the Aisinman oils that comes anywhere near the specific figures given in this question, which are from 10 to 20 gravity, is the one that is 20, is it not?

A. Yes, within the limit of your question.

Q. The limit of the question you were asked on direct, Doctor; your question on direct held you to a limit of from 10 to 20, did it not?

A. It did not. It was "approximately." It is the word before the "20," which is "approximately," and the oil I mentioned there was 25.

Q. The one that you mentioned was 20, was it not?

[fol. 518] A. I say the oil I am mentioning just now, a moment ago, was 25.

Q. Now, taking the one that is 20 and the one that you referred to in your direct; the table that you brought in this morning shows that the figures are further away from the Burton patent rather than closer, as compared with those you gave in your direct, does it not?

Mr. Rauber: I do not think I understand that.

The Master: I do.

Mr. Wiles: The witness started to use the table to explain his figures on direct.

The Master: Never mind explaining; never mind making more record on the thing. Answer the question (addressing the witness).

The Witness: Will you read the question, Mr. Reporter?

(Question repeated by the stenographer.)

A. The only change, as I see it, is that instead of being, as I said, about 20, which according to the other data, is now 20.65, and as such it is further away from the Burton.

The Master: To the extent of——

The Witness: .65.

The Master (continued): .65?

The Witness: It is a little less than that; there was a decimal on the other one.

Q. But you boosted your viscosity, which you said in your direct was from 135 to about 300, in the tables produced this morning to 341, have you not; so that instead of being 300 as a maximum, it is 341?

A. This was only about. It was used as 341.6 in my calculations of the other day, though it was not so answered in the question there as to the exact figure. Just as I said, about 20 degrees and about 300, in my answer.

Q. "About 300" meant 340 then, approximately?

A. About 20 meant 20.05 and it should be, using the A. P. I., 20.65.

The Master: Furthermore, there is the word, "approximately" in the question as to both factors??

The Witness: Yes.

Q. Now, in connection with this same patent you said, on page 375, that the shale oil lubricants are essentially the same as the Burton twine oil. Is it your position that the shale lubricating oils are of essentially the same character as this Burton twine oil?

[fol. 519] A. The shale oil lubricants are oils which for their density have very slight viscosity, in general.

In other words, that they are oils which are not very viscous, and at the same time may be moderately dense. That has been the one trouble with the lubricants made in the shale oil industry, that they have had trouble in making products that would correspond to thick, viscous oils, like cylinder oils.

Q. Is this a general characteristic of shale oil lubricants?

The Master: He said it was.

A. I think it is, in general.

Q. That would apply, for instance, to such oils as are made by the Catlin process, to which you referred in discussing that shale oil the other day?

A. I was thinking particularly of those larger commercial plants of France and Scotland. In the case of the Catlin plant I do not just know directly, though I have understood that they have been working for heavy products, and I had one letter from one man (of course it is hearsay evidence) that he had knowledge now of a scheme which would permit them to get heavy oils, instead of less viscous oils from the shale.

Q. When you speak of heavy there, you mean viscous oils?

A. Yes; I was referring to heavy viscosity rather than heavy density.

Q. Now, can you give us typical illustrations of the gravities and densities of the shale oils of Europe that you have just referred to? I mean those within your own personal knowledge, if you are taking it from the literature——

A. Including——

Q. No, I mean of your own personal knowledge?

The Master: Why limit him to his own personal knowledge; it is public?

Mr. Wiles: I will ask him about his references if he has got those. I want to know if he knows himself, first.

A. I think we have some oils at Columbia in the Chemical Museum there, which are lubricating oils made from shale oil, and those I have handled only, but I have not determined their viscosity or their gravity in numerical terms; at least, I do not recall them, and cannot give them from memory, if I have determined them.

Q. Now, what literature reference do you rely upon for this statement?

[fol. 520] A. I had in mind particularly the abstracts which I went over and read over, part of which I abstracted myself, amounting to a total of some 1120, as are given in the back part of the shale oil book, which I edited and which was published last June, and which I read over once last summer, and once earlier.

I think that in those articles there are mentions of that, and it is the general impression that I have from that, and I cannot give you the reference offhand.

I find, as confirming that, the statement of Lyder, under "Lubricating Oils," page 114:

"The Viscosity of the finished oil is considerably lower than that of internal-combustion engine lubricating oils."

And then, another statement:

"Lubricating oils with 375 flash point or higher can be produced from shale oil."

"Since only a small amount of work has been done on shale oil over different parts of the country, the average viscosity of American shale lubricating oils cannot be stated, but lubricating oil with a Staybolt viscosity of 173 seconds at 100 degrees Fahrenheit, have been produced commercially in this country. Viscosities of Scottish shale lubricating oils vary from 120 to 140 seconds and the average viscosity of the shale lubricating oils made in this country will apparently be about the same. The shale oil lubricants produced here, though of low viscosity, is apparently an excellent lubricant. Its viscosity decreases

somewhat less with increased temperatures than does that of petroleum lubricating oils."

This is from Lyder who is at the Catlin plant, or was at that time at the Catlin plant, where they were trying to make heavier viscosity oils.

Q. Those quotations that you have read, the only ones that you are able to give us now, show viscosities of something over one hundred, but they do not tell us anything about the gravity of those particular oils, do they?

A. No. In such a place as this, it is hardly important to determine viscosities and gravities of all the oils. In the lubricating oil, we know that, in general, they are within certain rough ranges; viscosity is the important thing in there generally.

The Master: For lubricants?

The Witness: For lubricants, yes.

Q. Now, you said in your direct that these oils had a low [fol. 521] viscosity for their gravity, or that in substance. Now, there are plenty of oils of all sorts of viscosities, but, as I understand it, the question is a gravity-viscosity relationship. Now, do you actually know the facts tbout th-s shale oil lubricant gravity-viscosity relationship?

A. Yes, I know it to this extent: That while I cannot give you the figures on the particular lubricants, I know that the trouble has been that the shale oil lubricants, in general, have had undesirably low viscosities; that is, undesirably low from the commercial viewpoint. I find here in these abstracts many cases of where certain gravities are given, but I cannot find viscosity on the same oil.

Q. Then you cannot find a description anywhere of these shale oil lubricants which gives, for the same oil, both its gravity and its viscosity?

A. I think I can.

Q. You have not found one here?

A. I have only looked for it since you asked your question, and I have been trying to look for it here, but I am not certain that it is even given in these abstracts, though they give many factors regarding oils.

The Master: You feel certain of the existence of such data?

The Witness: Yes, I feel certain. I would look particularly for it in European publications, rather than in American publications, because the shale oils are essentially Scottish and French.

Q. You testified here that these oils——

The Master: If you find any such you can produce them as exhibits.

The Witness: Yes, sir.

Q. You testified here in substance that these European shale oil lubricants had a low viscosity for their gravity?

A. That is correct.

Q. Now, Dr. McKee, you say that statement was correct, that you did so testify in substance?

A. I do not recall that I testified, but it is a correct statement; they do have.

Q. All right. Now, I want to know the data on which you based that statement at the time you made it in your direct.

A. From my general knowledge of the shale oil industry and of shale oil. I probably know more about that field than most people, or almost anybody else in this country.

The Master: From shale oil literature?

[fol. 522] The Witness: Yes.

Q. Now, can you tell us that you ever saw—you never tested it yourself; now, did you ever see anywhere any single report that gave both gravity and viscosity on the same oil, from which you have any idea of their relationship?

Mr. Rauber: I do not see that is quite pertinent, because there might be other things given that might indicate it, even though it were not expressed in just those terms.

A. If we have an oil which was known to have a gravity—known to be of rather heavy gravity, and it shook like that (indicating), without running it through a Saybolt viscosimeter, we would know that it was of low viscosity.

Q. And these lubricating oils that you have been talking about do shake like that sample of naphtha, that you just shook for the Master?

A. No, they are not that viscous, but they are much less viscous than many well petroleumn oils. They are more

like the light oils of the well petroleum, than they are the heavy cylinder oils. As I say, however, we can apparently get heavy cylinder oils from them by some of the schemes.

Q. Now, in the same matter immediately following on page 375, you said that you attributed the low viscosity to the presence of olefinic products, that is unsaturated hydrocarbons; that is still your position is it?

A. Yes. That is my impression or belief, and by "unsaturated hydrocarbons," we are using it in a fairly broad sense, not as to simple straight chain olefinic compounds of the simplest type.

Q. Now, how much sulphuric acid absorption do these shale oil lubricants, which you have stated are rendered of low viscosity, by reason of their unsaturated components actually show?

A. In the crude form, before they have been clarified or given chemical treatment, they, in general, show about the same percentage of olefinic character as the partially cracked gasoline or kerosene from shale oil which as been marketed. That is, of percentages from fifty to eighty per cent, roughly; sometimes outside of those numbers, but normally within that percentage.

Q. Now, Doctor, I was asking you about lubricating oil and you do not call crude products lubricating oil, do you?

A. They are the crude lubricating oils and then they are finished afterwards with a chemical treatment.

Q. All right, if you insist on that nomenclature, which I [fol. 523] never heard of, why, we will just double our record; but what I wanted to know was the sulphuric acid absorption of these finished lubricants that you say have low viscosity and this high content of unsaturateds.

Mr. Rauber: This patent is not limited to finished lubricants, as I understand it.

Mr. Wiles: He testified about Scottish——

The Master: Let him answer the question.

A. I do not recall any figures on finished lubricants.

Q. You say they are in unsaturation; how can you approximate the sulphuric acid absorption that they would have?

A. I would expect them to be pretty well up and to average perhaps (this is, however, only an expectation and not

a statement as to facts that I have carried out) to average about seventy-five per cent.

Q. Sulphuric acid absorption?

A. Yes, when a considerable excess of sulphuric acid was used in the test.

Q. That is the way you normally make the test, with a considerable excess of sulphuric acid?

A. Yes.

Q. In other words, when these shale oil lubricants are properly tested for sulphuric acid absorption, they show about seventy-five per cent absorption?

A. I have said that would be my guess or expectation.

Q. Yes. Now, how much sulphuric acid absorption would be shown by the Burton twine oil that we have been discussing?

A. It would be fairly high, but I have not determined, and I have never seen a publication which has determined it.

Q. About how high, in your judgment?

A. You wish me to guess?

The Master: If you do not know, just answer that way.

A. As I said, I have not determined it, and I do not know on that. I have not made an examination of it.

Q. Now, if you don't know and cannot estimate approximately their unsaturated character, how do you justify yourself in saying, on page 375, that these lubricants and the Burton twine oil are essentially of the same character?

A. Because, in the first place, I did not say that I could estimate it.

Q. What is your best estimate?

A. You wish me to guess?

[fol. 524] Q. I want the same kind of information that led you to say that they were essentially of the same character when you testified in direct.

A. Because they are products obtained in cracking and it is the residue product which is obtained normally by cracking in any—almost any liquid phase cracking process, not essentially different. And we know that, in general, in your cracking process, starting from a fairly saturated oil, such as a Pennsylvania oil, that it is seventy-five per

cent saturation, we will get products which are less saturated, decidedly less saturated, both in the distillate and in the residue, and the process by which it is made is the same process that we are familiar with, working on the same product, on the same raw material in times past, and the only place, as I understand it, that the Burton product is new, is the fact that they have put an equation on it and somebody had previously measured both the viscosity and the gravity and published it.

Nobody, for example, so far as I know, has measured the viscosity and gravity of cocoanut milk, and if it happened I do not feel that that is really a new thing to get; to measure that and then describe it and claim that nobody can grow it because you have measured it.

Q. Now, Doctor McKee, you have not answered; you have gone a long way from my question.

The Master: The general purport of his answer is that he bases his conclusion upon his knowledge and experience as a chemist.

Mr. Wiles: What I was trying to get at is this: In the matter I am interrogating him about——

The Master: I know about that.

Mr. Wiles (continued): He compared it with the European shale oil lubricants which he says will absorb 75 per cent sulphuric acid.

Now, I am asking him whether he knew or had reason to believe that this Burton twine oil, which he says is essentially the same character, absorbs to that same extent or a generally similar extent, or essentially the same extent.

The Witness: I would expect it (and this is the guess that you have been asking me for) to absorb about the same percentage; to be absorbed to about the same percentage.

Q. And your belief that it would absorb to the same extent is based on your general knowledge as a chemist of processes through which it passes in its makeup?

A. Yes. I have never analyzed it.

[fol. 525] Q. Now, Doctor, when we closed yesterday afternoon, I was on one branch of the case, which was interrupted by the production, this morning, of these other matters of yours.

As to the Schuchow & Gavrilow Russian patent,—that patent mentions fractional distillation, and also gas production, does it not?

A. It does mention both.

Q. And it does not say anything about cracking, which is inconsistent with its cracking only for gas, does it?

A. Yes. On page 1 of the translation, near the bottom, there is a statement:

"In these coils the liquid being put in them by the action of the pump, is heated to a high temperature, and dependent upon the dimensions of the pipes of the coils, and the speed at which the pump is operated, it is subjected either to the process of distillation, or to the process of decomposition."

Now, if it is heated to a single high temperature, as he states here, and the variation, as to whether they are going to make gas, or whether they are going to crack it or distill it, is only that of speed, it would be the speed of liquid passing through those pipes, heated to this same temperature—it would be naturally, that, instead of gas, by increasing the speed, you would get decomposition—that is, cracking. That is one place.

On page 2 of the translation we have:

"That the mixture of gases, vapors, distillates and residue liquid, which is formed in the coils, passes into the cylindrical vessel A, in which the liquid settles to the bottom, while the gases and vapors pass through the pipe, E, to the separator of the distilled products and the coolers."

In other words, we are getting gases and vapors simultaneously, and that would correspond to any cracking process.

Of course, in this it must be borne in mind all the way through, that this is a patent for machinery—that is, it is an apparatus patent, in which, only incidentally, is the process discussed. But if, in our process of heating of petroleum, we got gases and vapors passing over, we would have a cracking process taking place, and with the purpose of producing something else than gases, because, if we wanted only gases, we would heat to a higher temperature and not have the vapors.

Again, we have in the middle of that page, page 2 of the translation——

"The liquid is re-circulated—that is further submitted to a further treatment—by the aid of the cock, Q, it again [fol. 526] enters the pump, where it is mixed with fresh liquid flowing into the pump, and passes, in further circulation, through the coils."

If it was distilling, alone, it would have no occasion to do that.

If it was cracking for gas it would not be a normal scheme, in view of the fact that it is in the same paragraph where they speak of the gases or vapors passing through the pipe, E.

Again, we have here the use of the reflux, and if we were cracking for the production of gases, there would be no advantage in putting in a dephlegamator scheme or reflux scheme.

If we were cracking for the production of motor spirit, there would be.

I read again, from page 2 of the translation:

"A part of the liquid which is being distilled can be admitted directly into the cylinder, A, for the dephlegamation of the vapors formed in the coils."

On page 3, at the top of the page: "The structure which has been described, renders it possible, with a comparatively small expenditure of material for the construction of the heating surfaces in the distilling apparatus to distill and decompose a considerable amount of liquids, and in addition, through the action of the circulation, there are removed wastes and coke-like deposits, which are formed during the process of distillation and decomposition."

If it was a simple distillation, as I understand your question—the two alternatives—we would hardly expect to have coke-like deposits. But we can if it is a cracking process, or a gas process.

In other words, I have given five places, in these five pages of translation, of this apparatus patent, in which it mentions incidental process parts, agreeing with the purpose of the apparatus to be used for cracking to produce lower boiling oils.

Q. Now, I am going to take these one at a time—these five points that you have raised—and I think I may say, in the beginning, that I don't see why you and I should disagree about the fact that this patent states, first, that it does fracionally distill. You agree with that, do you not?

A. Yes—no—that it is an apparatus which could be used for fractional distillation.

[fol. 527] Q. Exactly. And it is also very clear that it may be used for the making of gas. That is clear, is it not?

A. It doesn't say making of gas. It says "Recovery of gas from petroleum and its products." That is repeated several times.

On the first page are the identical words, "recovery of gas from petroleum and its products." That occurs three times.

I don't find anything here, that is a plain statement that it can be used for the making of gas—only for the recovery of gas.

Q. When I asked you about that yesterday, didn't you insist that the recovery of gas, naturally present, could not be of any substantial consequence?

A. I think that is true.

Q. So that it must mean that he makes gas.

A. In the country where I came from, Missouri, a dog that is not a good bird-dog, or a good hunting-dog, is said to be a good coon dog, and when asked about it the owner of the dog will say that he isn't good for anything else, and, hence, he must be a good coon dog.

So I understand your argument must be of the same kind—that it must be for that, because it doesn't say anything else.

Q. But it says something about getting gas, so that he must make it.

A. I understand, of course, that in cracking, in any process, you will get some gas, and that you can crack and get gas.

Q. You know, of course, that in all gas making processes, there is some liquid residue?

A. Yes, sir, there are, normally.

Q. There is a substantial amount of liquid always made?

A. But you must remember that this patent is primarily concerned, as you will note by the number of parts given

to it, with the light liquids, which it gets, and not with the question of gas. Gas is given—say in the specification, and not in the figures themselves—is given as of very minor importance.

Q. Let us not get away from the point. The patent does state, you concede, that it fractionally distills. Doesn't it also state, in substance, that it makes gas?

The Master: What I want to know is, what difference does it make what it shows? If it shows a process for cracking, what difference does it make of what other things it shows?

Mr. Wiles: Well, what kind of cracking, your Honor?

[fol. 528] The Master: Well, that is a different thing.

Mr. Wiles: Well, of course gas making is a type of cracking—not a type that this suit has much to do with, as we view it, but it is a perfectly well known type of cracking—that is, the oldest and commonest.

A. I find no reference, here, to gases, in the way of recovery, excepting in the statement that "the object of the invention is the machinery which is represented in the plan, for the continuous fractional distillation of petroleum and other liquids, and also for the recovery of gas from petroleum, and its product."

The other translation that I have, reads——

Q. Let us not go into that. We have agreed on this translation, after much debate, Doctor.

A. All right.

Q. Those are the only stated objects of the patent, are they—fractional distillation, and the recovery of gas,—isn't that true, Doctor?

A. Those are the objects as stated in the patent, though the description, further along, is consistent with the cracking of oil.

Q. I understand your theory. Making gas is cracking oil, isn't it?

A. Yes, but I refer particularly to cracking oil to get motor spirit. It is consistent with that, as well.

Q. Now, you found five things which you said were inconsistent with this being the sole purpose practiced—gas making and fractional distillation—and the first of those was at the upper part of page 2—"The process of distillation, or the process of decomposition."

Now, the process of distillation is entirely consistent with fractional distillation, is it not?

A. The process of distillation is consistent with fractional distillation, yes.

Q. And the process of decomposition is consistent with an essentially gas making process, isn't it? And when I say "essentially," Doctor, you understand that I mean a typical gas making process, in which there is incidentally produced 15 to 40 per cent liquid?

A. Yes, sir, if you don't read the drawing which accompanies the article.

[fol. 529] Q. That part of the description is consistent, isn't it? I will come to the drawing later.

A. No, I wouldn't say that that part of the description is. I am answering your question—this part of the description is not consistent.

Q. Then mention in the patent of the process of decomposition, is consistent with its being decomposition essentially for gas making, is it not?

A. No, because the part which you referred to, at the top of page 2 of the translation—if we were going to consider it from the question of gas making, you would have the gases and residue liquid concerned, and you wouldn't be interested in the vapor—distillates, as he calls them.

Q. That is not the part that I am asking you about. I refer to the part regarding either the process of distillation or the process of condensation, or decomposition. I am going to take these one at a time. In my translation, that is about at the sixth line on page 2.

A. I find, now, what you are referring to, but it is on page 1, in my translation.

Q. Now, that language is consistent with this being a process, when there is decomposition, or decomposition for gas, is it not?

A. The words that you quote are, but the preceding part of the same sentence raises a question regarding it.

Q. Now, another point that you——

A. I think you missed my first point?

Q. No, I don't think I did. I heard just what you said.

A. You gave this as the first point—as I recall—the one we were discussing.

Q. That was your first point, was it not?

A. No, I read from three lines above that, first.

Q. The operating statement. Now, suppose you did want to run this for gas manufacturing, and make the most gas that you can make out of it—what you would do would be to fire hard and pump slowly—wouldn't you?

A. Yes. But in the phrase which we are referring to, it indicates it as a single temperature, roughly.

Q. Well, you would fire hard and——

A. That is what I would do.

Q. You would fire hard and pump slowly?

A. Yes, that is what I would do.

Q. And if you were trying to fractionally distill, you [fol. 530] would fire just about as hard, and pump as fast as you could, and get your cut off, wouldn't you?

A. No. You wouldn't fire hard enough to have your pipes at approximately red heat, for example.

Q. They could not get red hot if you pumped fast, could they?

A. No, but it is speaking, here, of the temperature of the coils, and not of the temperature of the fire.

Q. I realize that. Now, I am trying to get at the facts, to see whether this is a sufficiently accurate statement of what men would normally do. If you were trying to make the most gas, we agree that you would fire as hard as you could, and pump slowly, is that right? That is the right way to make the most gas, isn't it?

A. Yes, sir, that is my opinion.

Q. And if you wanted to get the greatest efficiency out of this device, as a fractional distilling device, you would fire just about the same amount, and you would pump just as fast as you could, and get your cut, wouldn't you?

A. I don't think you would, because if you did you would get carbon on your tubes, which would give you trouble, and you would have to use either—you would have trouble with it, and you would get cracking, instead of fractional distillation.

Q. Isn't that just the way they run all the pipe stills right now—fire them hard and pump them hard, and take up the heat with the huge charge? Isn't that the whole secret of the method with which the pipe stills are operated?

A. I told you this morning that I had never seen, and, in fact, I am not familiar with the pipe still for fractional distillation, in California, such as you speak of, but in this case

it is to be noted that it is at a temperature—it is not a question of the amount of heat that you are adding, but it is a question of the temperature at which it is held.

Q. Now, don't you know, as a matter of fact, that today there is an enormous technique built up, both in fractional distillation and in cracking, founded upon the principle of firing just about as hard as you can fire a coil, and pumping through it just as fast as you can pump, and get your cuts off in fractional distillation—don't you know that to be a fact?

A. Not in fractional distillation with a pipe still. As I said this morning, I am not familiar with that. I have not [fol. 531] seen the process, and I don't think I ever saw a detailed description of it.

In the cracking end of it we do it somewhat as you have stated here, but still we do not even approach the view that you have given, in that we put our burners at some distance away from the pipe and carry the flames in as long flames, rather than as short flames, which we could do if we used more burners, closer to the pipes, and feed them with air—particularly compressed air.

In other words, it would not be particularly difficult to double the amount of heat put into the ordinary cracking furnace below the boilers. We could do it, but we would do it at the risk of our apparatus.

The Master: You didn't understand the question the way I understood it.

The Witness: I understood that in the cracking they were using all the heating——

The Master: He wanted to know if you knew that there was a great technique developing in the cracking industry, by which they run their coils up to a predetermined high temperature, and forced the materials through under high pressure—feeding pressure.

The Witness: In that sense I know that there is such technique.

Q. But you say you don't know that they fire as hard as they can fire?

A. I think they could fire harder if they wished.

The Master: Firing harder means——

The Witness: Burning more oil in a given amount of time.

The Master: And raising the temperature under the coils?

The Witness: Yes, sir.

The Master: And it may be in one kind of a burner, or another kind of a burner—any burner that would get the coils up to a high temperature?

The Witness: Yes.

Q. Now, you next stated—in your next point—that the mixture of gases, vapors, distillates and residue liquids, which is formed in the coils, passes into the cylindrical vessel, A. Now, you say that is inconsistent with this being either a gas making process, primarily, or a fractional distillation process?

A. You have put in your quotation a comma, which is not in my translation, and which makes a distinct difference in the meaning.

[fol. 532] Q. I didn't put any comma in there.

A. Sure you did—"the mixture of gases, vapor distillates and residue liquids," is the way my translation reads. There is no comma between the word "vapor" and the word "distillates."

The Master: In other words, vapors is used as an adjective, rather than a noun.

Mr. Wiles: It couldn't be an adjective.

The Master: I think it could. They make adjectives out of almost anything now-a-days.

Mr. Wiles: I didn't say there was a comma there.

Q. Now, if this was a gas-making process, where we know that there is always 15 to 40 per cent of liquid, as a by-product, there will always be some gas, won't there?

A. Yes, and a residue liquid.

Q. And there will be some vapors—some light stuff?

A. Some, but not important.

Q. Well, there would be some, that would be in the mixture—that is all I want.

The Master: In the mixture, where?

Mr. Wiles: That goes out of the coil into the drum, at the top.

Q. Now, your next point was that they ran back their heavy residue to treat it over again. That is a very common practice in gas making, isn't it?

A. No. You forgot my next point, I think. While the gases pass through the pipe, they went to the separator and the distilled product and the coolers.

That is a part of that same one—that third one—and shows the interpretation to be placed on the vapor distillate.

Q. I am not on that point, at all.

A. I know, you are changing, but I think you are not giving the full view on that point that we have been discussing.

Mr. Wiles: I am through with that and I move to strike out that voluntary answer. I had passed to another point, your Honor.

The Master: He was answering, thinking that you were trying to re-arrange the steps of the process.

Mr. Wiles: May it all be stricken out, your Honor?

The Master: Oh, no, let it stay in. You may proceed.

Q. You didn't get what I was driving at, at all. Another point which you made, which you said was inconsistent with this being either straight gas making, or fractional distilla-
[fol. 533] tion, was that the liquid which settled in the drum, A, is returned to the coil, to be treated over again. Now, that re-use of the heavy part formed in gas making, is very common in gas making processes, is it not?

A. Not with the carbon in it, but in the case of cracking for making motor spirit, it is very common to return it.

In other words, if this had been used for the making of gas, we would expect either a straight distillation in between, to remove the coke and carbon suspended—and there would be considerable, if it was gas making, or if it was a motor spirit manufacturing process, or an illuminating oil manufacturing process, this cracking would only be partial, and the liquid would be still so liquid and contain so little carbon, that it could be run through the process again, for re-cracking, without handicapping the process.

So that it is a fact that we are able to send it back, and it is that question of the liquid that is the determining element in this case.

Q. Are you familiar with this oil gas cracking art?

A. Only moderately so. Some years ago I was interested in the product, and incidentally looked up the processes, to some extent. That was seven years ago.

Q. Well, it is the oldest and most wide-spread of all the cracking art—or it certainly was up to 1912, wasn't it?

A. Well, I was referring to the present-day Blau gas and Pintsch gas, and such as that.

Q. Oh, no, I meant the whole gas cracking industry—it is an enormous industry, isn't it?

A. Yes, in enriching illuminating gas and water gas, it is an enormous industry.

Q. And, furthermore, there is an immense industry, particularly in regions like California, where they have no coal, and where they make the entire gas for city distribution, out of oil—that is a fact, isn't it?

A. I have understood so.

Q. And long before there was any cracking for illuminating oil, or anything of that sort, this cracking, both under pressure, and not under pressure, for making gas, was perfectly well known, wasn't it?

A. I don't recall any reference to any oil cracking to make gas, earlier than '69, or '60, in the Newark cracking process, for making illuminating oil.

Q. But you do know, as a matter of fact, then, that it [fol. 534] was very common to take the heavy residues formed in gas making, and run them right back into the process, without any treatment, at all?

A. You mean before '61?

Q. All the time—that it is common in the art.

The Master: Common now, or common then?

Mr. Wiles: Common in the printed descriptions of the art.

A. That is common, particularly when you are using it to carburet water gas.

Q. It is common to take your heavy residues and run them back in, isn't it?

A. Yes, but you are not, in such a case, making your gas in a coil. You are making it in a brick work, or earthenware retort, and in such things as that.

Q. Now, it is common in the art of gas making, is it not—and, if you don't know, just say so—to take the heated residue and return them to metal distillatory devices, or apparatus used for that purpose, externally fired—isn't that true?

A. I don't know of any plant—in those large gas industries that I have referred to, I don't believe that they use metal cracking vessels. I might say that it is common where they have large diameter vessels—where any carbon deposit, there, would not clog the vessel.

Q. And Schuhow might have had some such an idea as that, perhaps, and not realized that he might get himself into this carbon trouble which you predict for him—isn't that true?

A. I am not a mind reader, and I can not tell whether he had any such idea, or not.

Q. Now, you also say that the use of these reflux devices indicates cracking to make motor spirit. I will ask you, on that point, first, whether the refluxing that you have in mind, is that up in the drum, A?

A. I referred to the addition—"independently of the flow of the liquid which is being run into the pump, a part of the liquid which is being distilled can be admitted directly from the chamber, A, for the dephlegamation of the vapors formed in the coils.

[fol. 535] The method of doing so is not shown on the sketch, but he simply speaks of it as an alternative method.

Q. Now, that drum, in fact, is packed with a packing of some sort, isn't it?

A. Yes. He suggests that it may be used with coke, or cast iron pieces.

Q. You would have in mind, by that, the general kind of packing that they put in reflux devices, would you not?

A. Yes, and to make a reflux work you ought to add a liquid above it, as I have indicated in my answers relative to the Lewis and Clark patents.

Q. And he very wisely does that?

A. Yes, sir.

Q. And that gives you a fairly cold top, and a cooling which progresses down all the way through the tower, and spreads down to the bottom?

A. Yes, but this tower, A. or cylinder, A, is of short height, so that that cooling would be very minor.

Q. Well, it is supposed to be quite cool at the top, in order to take care of the temperature of your outgoing distillates, and to get warmer towards the bottom—that is the way all reflux devices that are properly made, work, isn't it?

A. Not quite cold at the top. It is expected to be, in such a case as this, probably at a temperature of 500 Fahrenheit, or something like that—or 600.

Q. What is it that you understand him to be making, here?

A. He is making, as I understand, illuminating oils and gasoline, by a cracking process.

On the other hand, he may be fractionally distilling products, and trying to get a separation of the heavy products which would carry the gasoline and illuminating oils into the vessels to the right, in the figure—these partial condensers, where he separates the various fractions. If he was using it for making gas, there would be no point in using a reflux.

Q. And the temperature of that would be around five hundred?

A. It would depend on whether he was working for gasoline or kerosene products.

Q. Would you put it around five hundred and fifty for kerosenes—or somewhere on that order?

A. I think if you would want to use it for kerosene, you would want to run it even higher than that.

Q. Six hundred?

[fol. 536] A. Yes, around six hundred. It would depend a little bit on the question of the height above the dephlegamator—if the dephlegamator was tall, taller than indicated in the diagram—the temperature would not need to be so high. If it was shorter than indicated in the diagram, the temperature might even be higher.

Q. Now, if you were trying to run this for gasoline, you would run it higher—around 500 or 450, or somewhere in there?

A. Somewhere in there.

Q. Now, this reflux is entirely consistent, and would be a highly desirable thing to do in a fractional distillation operation, when there was no cracking, wouldn't it?

A. No, I don't believe so, because, if you were going to fractionally distill, there, you would simply heat your oil up to about the proper temperature for it to boil off, and there wouldn't be any necessity to chill again. Of course, by the use of a dephlegamator, you can get, possibly a somewhat shorter cut, but it is not very desirable in the case of fractional distillation.

Q. But it can be done, and is quite consistent with fractional distillation, is it not?

A. Yes, sir, it could be done, but it is not very likely to be done.

Q. It would give you a nice sharp end point, wouldn't it?

A. If you would use a good dephlegamator—not a simple scheme such as this.

Q. Well, a properly packed receptacle is a pretty good dephlegamator, isn't it—according to your testimony?

A. Not of one the height shown in this figure.

Q. Now, you said, Doctor, that you had five points, and I seem to have covered only four. Have I missed one here, somewhere?

A. I think the fifth point was in connection with page three, there.

Q. Oh, that is the pumping end. It is the same reflux—that is, you amplify your reflux in connection with that.

—. ——.

Q. I wish you would turn to the Pielsticker patent, please. Primarily we have an American and a British patent to this same man. They are essentially the same, aren't they?

A. They are essentially the same. There is a little difference, as I recall, but only minor differences.

Q. The difference makes no difference in this case—one is just as good as the other, isn't it?

A. I don't know.

Q. Well, if there is any difference, that is, in any sense, important, I wish you would call it to my attention. Otherwise, I would rather just consider one patent.

The Master: I assume that you will elect, yourself, what patent you will pursue, and then ask about the similarities of process in the other patent, when you get through.

Mr. Wiles: Well, perhaps, that is the shorter way.

Q. Now, under the Master's suggestion, I will go ahead with the United States, Pielsticker patent.

The Master: Which is prior in date of publication?

The Witness: The British patent—by one year, roughly.

Q. Now, you used this reference in connection, I believe, with the Ellis cracking patent process, didn't you?

A. I think I used it in connection with the Ellis process patent, No. 1,415,232, but not with the other Ellis patent.

Q. That is the cracking process patent, isn't it?

A. Yes.

Q. There are two Ellis process patents—one is a cracking process and the other is a treating process—isn't that true? [fol. 537] A. Well, a refining process—if you use treating in that sense.

Q. Now, in this Ellis patent, it is specified, is it not, that there shall be no rise in temperature in the drum?

A. The original specification——

Mr Myers: My associate suggests that that statement is just contrary to that which is found in the patent, and, if so, I think the question is objectionable, your Honor.

Mr. Wiles: I think you misinterpreted the question. The question is as to the rise of temperature in the drum, and——.

The Master: The witness is competent to answer the question. He may answer.

A. On page 5 of the file wrapper——

Q. I didn't ask you about the file wrapper, Doctor. I asked you about the patent. Will you answer it as to the patent?

A. Page 1 of the specification, it states, line 91, "The products of combustion from the heaters below the decomposition tubes, pass up and around the drum, and in some cases may add heat to it, and in other cases serve more as an insulating blanket of heated air, to prevent any substantial drop of temperature in the drum, 8."

This would imply that as they added heat to it, that it gets to the higher temperature.

On the other hand, I find in claim 3, the second alternative mentioned here,—"that is effected without increasing their temperature."

And that is true, also, at least of claims 4 and 5. Claim 6 also specifies no rise in temperature, and I think that that is true of still other claims.

In other words, we have one thing in the specification—or an alternative in the specification, describing the invention, and in the claim we have only one phase of it covered.

Q. Do you understand the statement in the specification, lines 94 and 96, on page 1, which you quoted, to set forth two alternative processes?

A. Yes.